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Forest Bulletin No. 13 1913

Note on *Ligno Protector* as a possible means of Preventing Timber from Splitting while Seasoning

BY

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ENDS OF LOGS TREATED WITH LIGNO AFTER 2½ YEARS.

A. Odina Wodier.
B. Abies Pindrow.
C. Albizzia odoratissima.
D. Lagerstrœmia microcarpa.

Note on *Ligno Protector* as a possible means of Preventing Timber from Splitting while Seasoning.

By R. S. PEARSON, F.L.S.,

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INTRODUCTION.

THE question of seasoning timber is one of extreme importance to which relatively little attention has been paid in India.

The process of seasoning may be carried out with the object of strengthening the timber, increasing its durability, reducing its tendency to warp and contract, preventing it from splitting, and of immuning it to insect attack or of establishing one or more of these conditions, according to the technical qualities of the timber under consideration.

The experiments, the results of which are given below, were carried out in order to ascertain the efficiency of **Ligno Protector** when applied to certain species of timbers to prevent them from splitting during the process of seasoning.

The idea of carrying out these experiments with **Ligno** was conceived by Mr. A. J. Gibson, Deputy Conservator of Forests, in 1908, during the time he officiated as Imperial Forest Economist, the experiment itself being carried out by the writer.

1. Methods in Common Use for Seasoning Timber.

It is not here proposed to discuss in detail the various methods by which timber may be seasoned but only to mention briefly a few of those in common use. Teak is generally seasoned standing, especially in Burma and on the West Coast. This is accomplished by ringing the tree

in order to kill it gradually, after which it is felled, usually three years after it has been girdled. A more common method adopted in India, especially with species other than Teak, is to fell the trees and allow the log to season either in the forest or in depôts. Another method in vogue, where rivers or streams occur, is to season the green logs by immersion in the water for a period varying from six weeks to six months, or again, logs may be seasoned in brackish water, as for instance at the mouth of rivers, after which the process of seasoning is completed on land. On the West Coast, and no doubt elsewhere, a practice exists of burying the logs in the brackish mud which accumulates at the mouth of tidal rivers, leaving them there for a year or more after which they are placed in a shady place to dry.

In India partial water-seasoning is common, the practice being rather due to force of circumstances in connection with floating operations than to any pre-conceived plan for seasoning the timber. The result is not quite the same, for while floating timber a portion of the log is necessarily out of water, whereas when immersion takes place with the direct object of seasoning the timber, the log is completely immersed. In making the above remarks it has been assumed that the timber is being seasoned in the log, as in opposition to seasoning timber after conversion.

In some cases it is necessary to convert the timber at once, either partially or altogether. The practice of sawing a billet of box-wood with a longitudinal cut to the centre, to prevent splitting, is an instance of partial conversion while seasoning, whereas the conversion of *Bombax malabaricum* timber as soon as it is felled is an instance of the necessity of converting timber in a green state in order to prevent discolouration and warping.

Whatever may be the method of seasoning employed, whether on land, in water before or after conversion, or by girdling, the main object in view—leaving artificial seasoning in air-dried chambers, etc., out of the question—is (*i*) to retard the process of seasoning and (*ii*) to allow all portions of the timber to season uniformly.

In order to retard the process of seasoning, the most common method in vogue is to protect the timber from the direct rays of the sun. This is accomplished by either storing the timber in shady places in the forest, in seasoning sheds, by immersion, by covering the logs with grass or leaves, or by burying them in the mud of tidal rivers.

In order to bring about the second condition, namely, uniform seasoning, the log or converted material is stored off the ground or piled in such a way that free circulation of air takes place all round the timber. Such steps are necessary and desirable, but such treatment by no means ensures uniform seasoning, for the reason that only the exterior surface of the timber is affected. In order to obtain uniform contraction of the tissue it is absolutely necessary that the internal and external layers of the timber should give off their moisture at approximately the same rate. If this does not take place, owing to the rapid evaporation and consequent premature contraction of the outer tissue, as compared with the slower process which takes place in the heart-wood, the fibre becomes ruptured and fissures occur such as heart, star, or cup-shake.

In order to retard the excessive evaporation from the sides of the timber the bark may be left on or water poured over the log from time to time.

To check excessive evaporation from the cut portion at the end of the log, which is most exposed to the action of atmospheric influences, tar is not infrequently applied. Another method is to paste brown paper on the exposed surface or to apply a mixture of cow-dung and mud, either processes giving in some cases very fair results.

There can be no doubt that it was with the above-mentioned principles in view that the promoter of **Ligno** set to work to find a possible substance for application to the ends of logs, which would retard evaporation and so bring about those conditions most necessary to stop the timber from splitting.

2. Object of the Experiments, and Conditions under which they were carried out.

As has been stated in the introduction that the object of this experiment was to ascertain the value of a patent substance known on the market as **Ligno Protector,** which, it is maintained, prevents timber from splitting.

In order to obtain conclusive results, it was determined to give the process as severe a trial as was possible within working limits. With this object in view the species of timber chosen for treatment were of those kinds known to be very liable to split while seasoning. The list of these species will be found in the tabulated form of results. Further, the logs

to which the solution was applied were cut 18″ in length from trees of three to four feet in girth, thus, owing to their shortness making them extremely liable to split from end to end. Two specimens of each species were cut from each tree, one for treatment, and the other to be kept for comparison. The treated and untreated logs were then placed on stands in an iron-roofed godown, so that though free circulation of air took place all round the specimens, the heat under the tin roof was excessive, especially during the summer months. And lastly, so as to ensure more uniform seasoning, the bark was left on each log.

3. Method and Cost of Treatment.

Ligno is a light brown plastic substance of the consistency of thick paint. The method of treatment is to apply a fairly heavy coating, about $\frac{1}{16}$″ in thickness, to both ends of the log.

In order to ascertain the approximate cost of treatment, two boards, each a square foot in size, were covered on both sides with a coating of the substance, one board receiving a moderate and the other a very heavy coating of **Ligno.** Both boards were weighed before and after treatment, with the result that the first weighed 4 oz. and the second 13 oz. more after treatment, or, in other words, the amount of **Ligno** applied worked out to 2 oz. and $7\frac{1}{2}$ oz. per square foot respectively.

The cost of **Ligno** in England is 22 shillings per cwt. when shipped in large consignments, to which £1 10*s.* per ton, or 1*s.* 6d. per cwt., must be added for freight, say 2 shillings per cwt., including handling or a total cost of 24 shillings per cwt., landed in India. The cost of treatment with a moderately thick coating therefore works out at 3·9 pies per square foot and for an excessively thick coating at 1 anna 2·5 pies per square foot. It was thought at the time that the moderately thick coating might have been slightly strengthened, so as to raise the cost of treatment to 4 pies per square foot. As a further example of the cost of treatment it may be stated that to treat both ends of a log with a mean girth of 6 feet, works out to 1 anna 10 pies or including cost of labour to 2 annas per log, a by no means excessive expenditure, provided the log is saved from cracking seriously.

4. Rate of Seasoning.

As has been stated elsewhere one of the main objects in view when

seasoning timber, is to retard the process in order to allow the fibre to contract gradually.

The actual rate of seasoning can only be accurately determined by carrying out periodic moisture tests. This work was carried out by Mr. Puran Singh, the Forest Chemist, with the following results :—

Species.	Treated or Untreated.	Date of taking moisture tests.			
		12th April 1910.	7th November 1910.	1st April 1911.	23rd April 1912.
		Per cent.	Per cent.	Per cent.	Per cent.
Pinus longifolia .	Treated.	39·98	30·52	20·12	10·52
Ditto . .	Untreated.	12·21	13·78	10·53	8·28
Quercus dilatata .	Treated.	36·93	38·18	24·18	8·86
Ditto . .	Untreated.	14·49	23·77	10·26	8·25
Dalbergia Sissoo .	Treated.	29·96	18·28	11·45	8·94
Ditto . .	Untreated.	13·62	15·47	11·80	8·67
Odina Wodier .	Treated.	46·81	33·68	12·86	8·80
Ditto . .	Untreated.	41·48	26·29	11·24	10·07

The logs were treated on the 9th July 1909, the timber at the time being in a completely green state, while the first moisture test was carried out in April 1910, about 10 months after treating the timber. At the time of treating the timber, as the duplicate specimens were originally cut from the same tree, they may be said to have contained the same amount of moisture. After 10 months the average amount of moisture in the four treated specimens was 38·42%, and in the untreated specimens 20·45%. The more rapid seasoning of the untreated timber is most marked.

The next moisture tests were taken on the 7th November 1910, after an interval of 7 months, during about 5 months of which rain fell. The average amount of moisture lost by the treated specimens during that period was 8·26%, as against ·62% from the untreated timber. During this period

the treated lost more than the untreated timber, while in three out of four specimens the amount of moisture in the timber was actually greater than during April 1910. This circumstance may appear at first sight to point to some inaccuracy. The writer is, however, convinced that this is not the case, for similar results have been obtained in connection with other experiments. For instance, in the case of Toon timber, it swells and again contracts during periods of rain and excessive dryness, due to alternate absorption and evaporation of its moisture. Again, the treated pieces with sealed ends would be less likely to be affected by alternating periods of damp and dryness than logs, the ends of which were not so protected, and this was actually the case.

The third set of moisture tests were carried out in April 1911, after a period of excessive dryness. The treated pieces at this period contained an average of 17·15% of moisture, while the moisture in the untreated pieces amounted to 10·96%, a difference of 6·19%.

The last moisture tests were carried out on the 23rd April 1912, or slightly over 2½ years from the time the logs were originally treated. The treated logs contained 9·28% and the untreated timber contained 8·82% or a difference of ·46%. Without exception all the treated and untreated logs were at that period thoroughly seasoned.

Now, the point of interest in these experiments is that it took the untreated timber exactly one year less to reach an average of 10 21% of moisture than it did for the treated pieces to reach 9·20%, in other words to become thoroughly seasoned, and this fact is no doubt due to the evaporation being checked from the ends of the treated logs.

5. Results Obtained.

In order to ascertain the results of treating the specimens with **Ligno** they were examined from time to time and comparisons drawn and recorded between the treated and untreated specimens. It is not here proposed to give in detail the result of each inspection, which amounted to twelve in all, during the period of two and-a-half years, as by doing so the records would become too bulky, while comparison would be difficult. Sufficient is it to state that during the rainy periods the cracks which had formed appeared to close up to a remarkable extent, while during periods of dryness they again expanded.

The results of the last inspection, which was made on the 6th June 1912, during a period of dryness, are tabulated below :—

Serial No.	Species.	Treated or Untreated.	Results of the last inspection made on the 6th June 1912.
1	*Picea Morinda.*	Treated.	One large and several fine radial cracks.
2	*Ditto.*	Untreated.	One large and three small cracks extending from side to side, and three fine radial cracks.
3	*Pinus longifolia.*	Treated.	One large radial crack, 4 inches in length.
4	*Ditto.*	Untreated.	Five fine radial cracks and three very fine star-shake cracks.
5	*Quercus dilatata.*	Treated.	Three large radial cracks, extending to within an inch of the centre, three fine radial cracks and a slight tendency to cup-shake.
6	*Ditto.*	Untreated.	Three large deep cracks, extending to within two inches of the centre, several fine radial cracks and a slight tendency to cup-shake.
7	*Abies Pindrow.*	Treated.	Sound.
8	*Ditto.*	Untreated.	Two large and one fine radial cracks.
9	*Quercus incana.*	Treated.	One very large, one large and several fine radial cracks.
10	*Ditto.*	Untreated.	One very large and several small radial cracks ; the treated piece is, if anything, more faulty than the untreated piece.
11	*Ægle Marmelos.*	Treated.	One moderate and five short radia cracks.
12	*Ditto.*	Untreated.	Four moderate and many fine compound radial and star-shake cracks.
13	*Bombax malabaricum.*	Treated.	One large and six fine radial cracks, also a few short fine star-shake cracks.
14	*Ditto.*	Untreated	One large crack extending from side to side, one large and three fine radial cracks, and several fine star-shake cracks.

Serial No.	Species.	Treated or Untreated.	Results of the last inspection made on the 6th June 1912.
15	*Dalbergia Sissoo.*	Treated.	One moderately large and one fine radial crack.
16	*Ditto.*	Untreated.	Two moderately large, one extending to centre and one to within 2 inches of the centre and several short, fine radial cracks.
17	*Odina Wodier.*	Treated.	Sound.
18	*Ditto.*	Untreated.	Nine fine radial cracks, one fine crack, extending from side to side, and one large crack right across the length of the log.
19	*Albizzia odoratissima.*	Treated.	Two moderate and one fine radial crack, one fine star-shake crack.
20	*Ditto.*	Untreated.	Two fine radial and many fine star-shake cracks, and one fine crack extending from side to side.
21	*Boswellia serrata.*	Treated.	One moderately large radial crack extending to within 2 inches of the centre, together with five fine short radial cracks.
22	*Ditto.*	Untreated.	One moderately large radial crack, extending to within ½ inch of centre and three fine radial cracks.
23	*Lagertræmia microcarpa.*	Treated.	Seven fine radial cracks, extending nearly to centre, one fine star-shake crack.
24	*Ditto.*	Untreated.	Eight fine and one large radial crack, extending nearly to centre, one crack extending from side to side.
25	*Xylia dolabriformis.*	Treated.	Several fine radial cracks extending only to edge of the heart-wood, one short fine star-shake crack, and one fine cup-shake crack, probably an original defect in the timber.
26	*Ditto.*	Untreated.	Many fine radial cracks together with a network of compound fine star and cup-shake cracks, one moderately large star-shake crack.

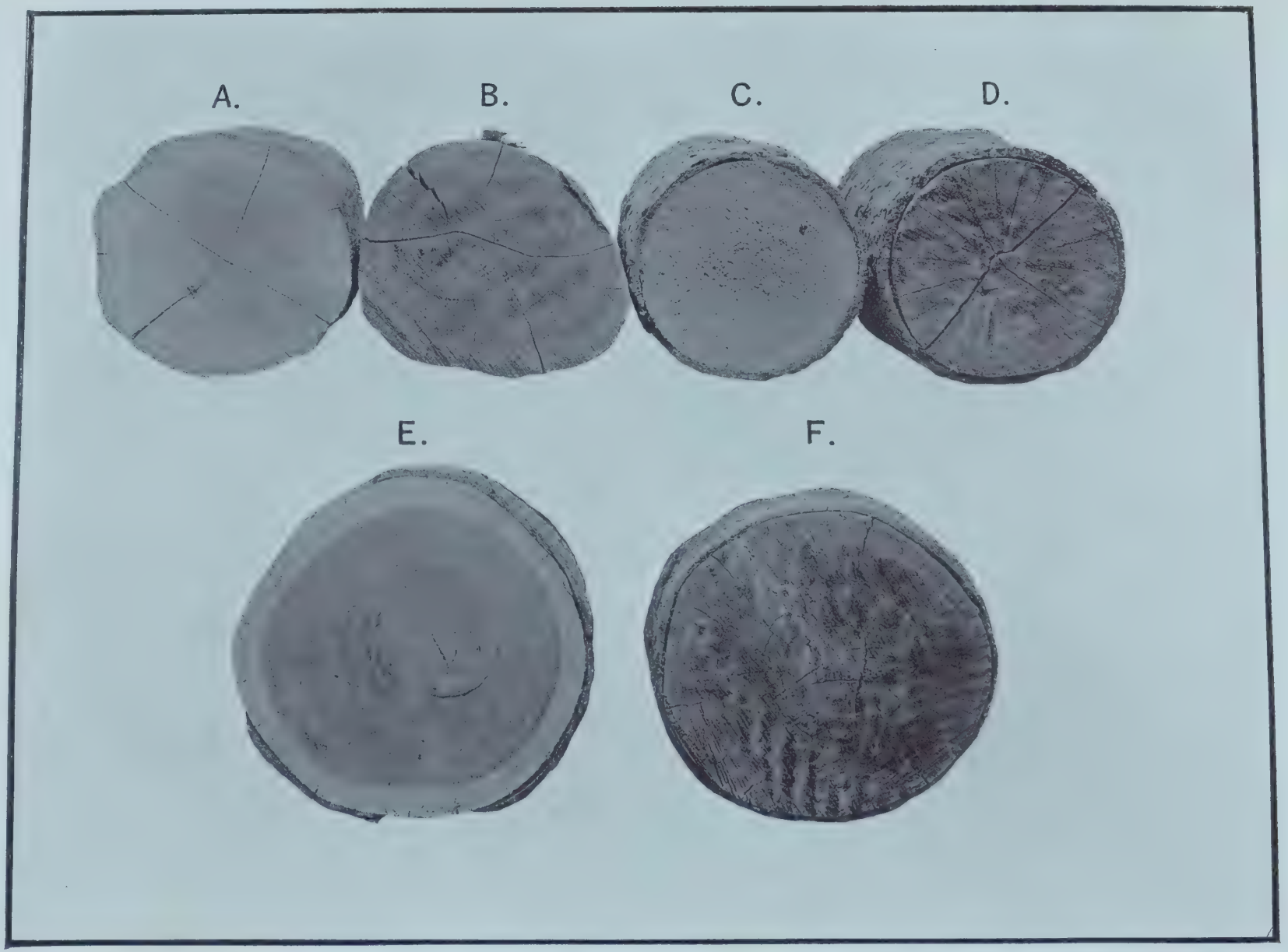

Photo by T. B. Chitrakar. Photo.-Mechl. Dept. Thomason College, Roorkee.

ENDS OF TREATED AND UNTREATED LOGS AFTER 2½ YEARS.

A. Lagerstrœmia microcarpa, Treated.
B. Lagerstrœmia microcarpa, Untreated.
C. Odina Wodier, Treated.
D. Odina Wodier, Untreated.
E. Xylia dolabriformis, Treated (from Bombay)
F. Xylia dolabriformis, Untreated (from Bombay)

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Serial No.	Species.	Treated or Untreated.	Results of the last inspection made on the 6th June 1912.
27	*Pinus excelsa.*	Treated.	One very deep large split from the circumference to the centre.
28	*Ditto.*	Untreated.	One very deep large split from the circumference to the centre. There is little to choose between the two specimens.
29 and 30	*Ditto.*	Put in tank to find out whether the treatment would prevent water-logging and so prevent the wood from sinking.	Neither treated nor the untreated pieces have sunk.
31	*Xylia dolabriformis.* (From W. Division, Kanara.)	Treated.	Several fine radial and star-shake and some fine cup-shake cracks.
32	Ditto.	Untreated.	One fine crack from side to side and several fine radial and star-shake cracks.
33	Ditto.	Treated.	Several fine star and radial cracks and also tendency to cup-shake.
34	Ditto.	Untreated.	Several fine star and radial cracks and also a tendency to cup-shake. There is little to choose between the two specimens.

It is impossible to give an absolutely correct idea of the state of affairs by tabulating such records. In order to obtain a clearer idea of what has taken place, photographs of some of the logs were taken, after the narrow slab of wood, on which the solution had been applied, had been removed.

Plate I illustrates three sets of specimens, of which A, C and E were treated (the Ligno having been removed for photographic purposes), while B, D and F were untreated pieces. In the case of *Odina Wodier* and *Xylia dolabriformis,* the treatment has been effective, while in the case of *Lagerstrœmia microcarpa* it has been only partially effective.

Plate II illustrates three further pairs of logs. Here again A, C and E were treated while B, D and F represent the untreated pieces. In the case of the pine and oak (upper line) the treatment was ineffective. Both these species are very liable to split, especially *Quercus incana*. The *Albizzia odoratissima* treated specimen shows considerably better results than the untreated piece, though the result cannot be said to be entirely successful.

Plate III illustrates two pairs of specimens, of which A and C were treated while B and D were untreated specimens. Here the treated piece of *Ægle Marmelos* developed some slight radial cracks, whereas the untreated piece became badly cracked. The *Abies Pindrow* treated specimen was completely saved from cracking, whereas the untreated piece developed two large cracks.

6. Conclusions.

The conclusions arrived at from these experiments are that (*i*) the seasoning process is without doubt very considerably retarded, a most desirable circumstance, (*ii*) that **Ligno Protector** by no means absolutely prevents timber from splitting, and though effective in some cases, it is absolutely incapable of protecting such species as *Quercus incana* from doing so, (*iii*) that before any definite opinion can be formed as to its commercial value it will be necessary to give it a trial on a large scale, and under natural conditions.

It is hoped that some Forest Officer in charge of a timber depôt will undertake such an experiment, especially with some of the more important species which are liable to split such as *Pinus longifolia*, or *Pinus excelsa*, *Xylia dolabriformis*, *Lagerstræmia microcarpa*, *Dalbergia latifolia* and *Terminalia tomentosa*.

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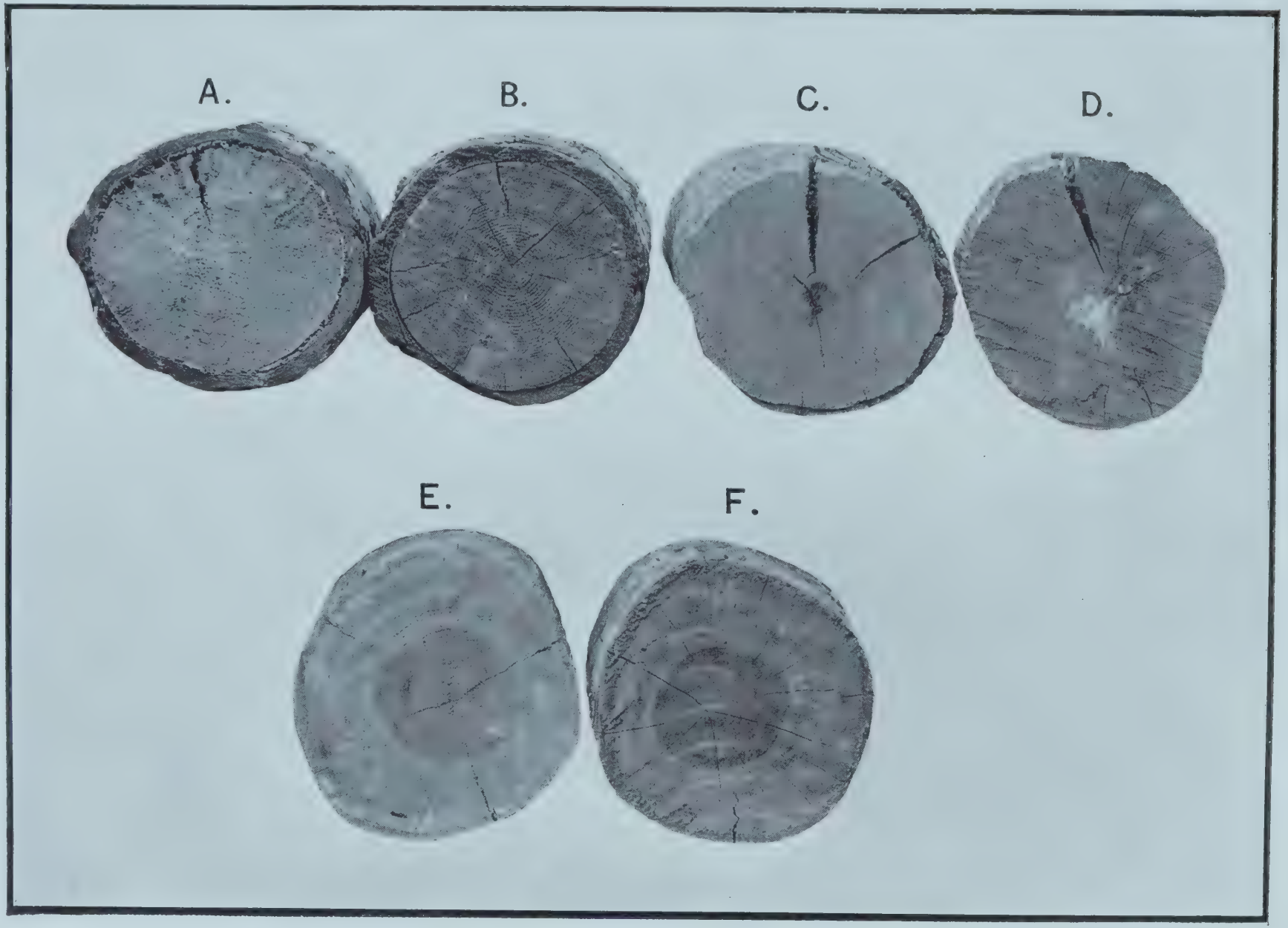

Photo. by T. B. Chitrakar.

Photo.-Mechl. Dept. Thomason College, Roorkee.

ENDS OF TREATED AND UNTREATED LOGS AFTER $2\frac{1}{2}$ YEARS.

A. Pinus longifolia, Treated. B. Pinus longifolia, Untreated. C. Quercus incana, Treated.
D. Quercus Incana, Untreated. E. Albizzia odoratissima, Treated. F. Albizzia odoratissima, Untreated.

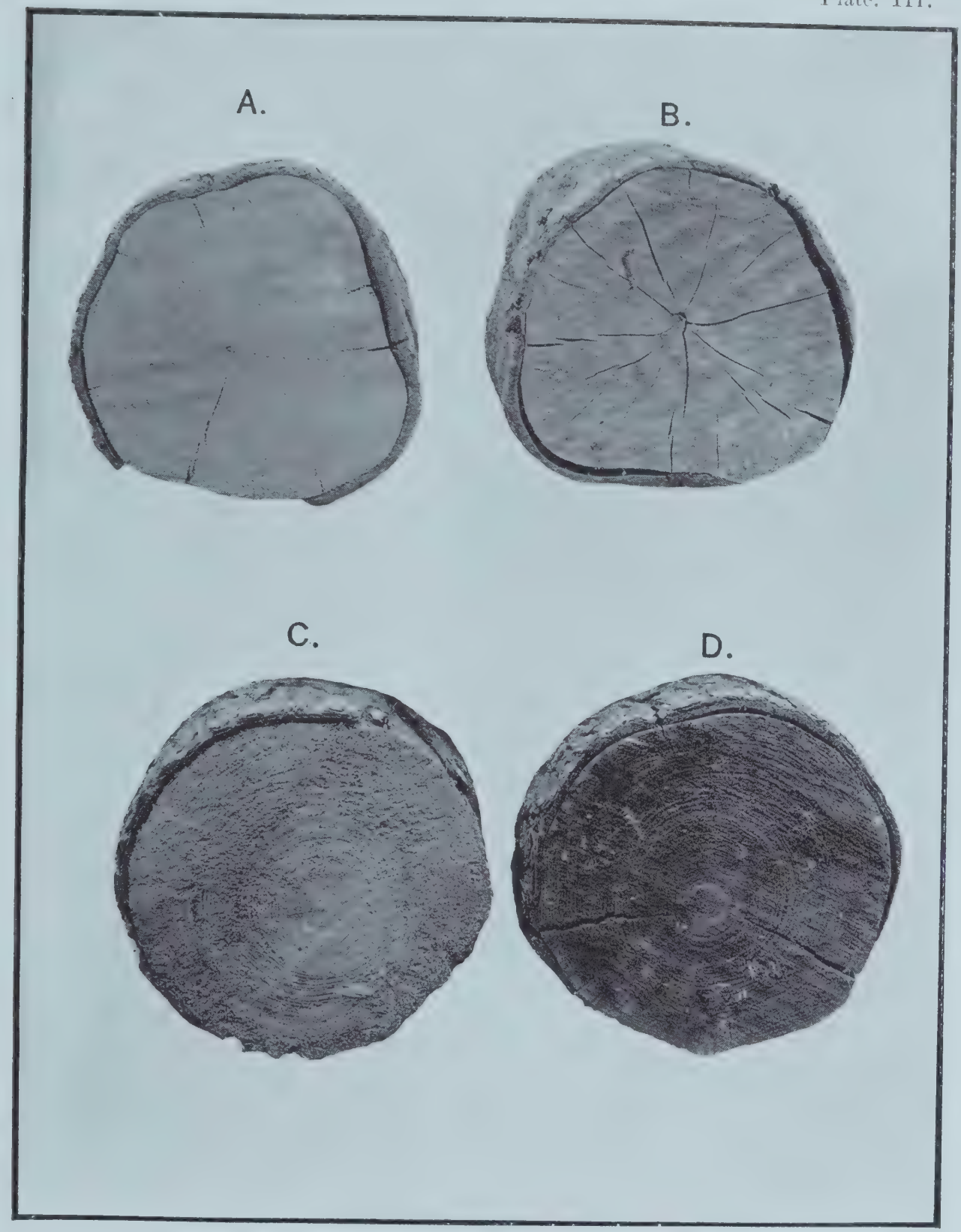

Photo. by T. B. Chitrakar. Photo.-Mechl. Dept. Thomason College, Roorkee.

ENDS OF TREATED AND UNTREATED LOGS AFTER 2½ YEARS.

A. Ægle Marmelos, Treated. B. Ægle Marmelos, Untreated.
C. Abies Pindrow, Treated. D. Abies Pindrow, Untreated.

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A Further Note on the Relative Strength of Natural and Plantation-Grown Teak in Burma

BY

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INTRODUCTION.

IN 1910-11 a series of experiments were carried out with a view to ascertain whether *plantation-grown* teak in any way differed in strength from that grown naturally. The results of the first set of experiments were published in *Forest Bulletin* No. 3, of 1911.

The tests made on *plantation* and *natural-grown* teak, the results of which are given in the above-mentioned publication, were carried out on timber obtained from the Zigon Division of the Pegu Circle of Burma. It was, however, not known whether the timber with which the tests were made was obtained from approximately equal-aged trees, nor whether the naturally grown trees were felled in the neighbourhood of the plantations from which the *plantation-grown* timber was obtained. Further, in the former set of experiments the *plantation-grown* timber was felled green and afterwards allowed to season, while the *natural-grown* timber was seasoned standing, by girdling the trees three years before they were felled.

Under the circumstances it has been thought advisable to carry out a further set of experiments with both *natural* and *plantation-grown* timber, which had been grown and seasoned under similar conditions. The results of, and conclusions derived from, these experiments are given below.

I.—Method of testing the Timber.

The work of testing the timber was carried out at the Sibpur Engineering College, under the direction of Mr. Heaton, the Principal, the actual work being done by Mr. Ballantine, the Foreman Instructor. The machine used was the same as that with which the writer tested the teak specimens, the records of which are given in *Forest Bulletin* No. 3, of 1911.

II.—The Locality from which the Timber was Obtained.

In order that the tests to be carried out should be conclusive, timber specimens were obtained from two different localities, namely from the Zigon and Tharrawaddy Divisions of the Pegu Circle of Burma. With a view of obtaining specimens of timber which fulfilled the necessary conditions and to enable fair comparisons to be drawn between *natural* and *plantation-grown* teak, trees were girdled both in the Hills and Plains, and also in Fire-protected and Unclassed or Non-fire-protected forests.

The writer is indebted to Mr. Smales, Deputy Conservator of Forests, Zigon Division, for sending two specimen logs of girdled teak, extracted from inside the Kangyi Brandis plantation of 1864, situated on flat alluvial soil, five specimen logs of girdled teak from just outside this plantation, five logs of girdled teak from the hill plantation, compartment No. 15 of the Bawbin Reserve, and five girdled teak, from just outside the plantation. Mr. Smales, in taking the greatest care to select the logs so that they should all be of approximately equal age, rejected three logs out of the five of the first series, as he had doubts as to their being of plantation origin. All the above logs were girdled in 1908 and felled in 1911.

The Tharrawaddy specimens were kindly sent by Mr. Walsh, Deputy Conservator of Forests in charge of that division. They consist of thirty girdled logs, of which ten were obtained from the plantation of 1869, compartment No. 4, in the Kadin Bilin Reserve. Of these five were felled by mistake in 1909, and were stored, raised off the ground, in the neighbouring rest house compound, while the other five remained standing for three years and were felled in 1911. Ten other logs were obtained from girdled trees standing in the neighbouring natural fire-protected forest adjoining the plantation, and from the same compartment

in which the plantation is situated. The remaining ten logs were from the natural forest adjoining compartment 4, but outside the reserve. This forest has never been protected and as it is adjacent to the fire-trace, Mr. Walsh states that it has probably been burnt regularly every year. Twenty-five of these trees were girdled in February 1908 and felled in February 1911, the remaining five being felled in 1909.

III.—Conditions under which the Timber was Tested.

From what has been stated above it will be seen that the timber to be tested was obtained from trees of approximately the same age, and that with the exception of the five logs cut in Tharrawaddy before they had had time to season standing, all the timber was seasoned standing for a period of three years. Another important point is that both the varieties of timber from the plains were obtained from the same compartment and the same was the case with the two varieties of *Hill-grown* teak and three sets of Tharrawaddy teak.

We have also to consider the question of the percentage of moisture in the timber, without knowing which no true comparisons can be drawn. In the case of Zigon specimens the extremes of variation were 10·81 per cent. and 13·05 per cent., while the other 15 moisture tests taken fell between these limits. In the case of the Tharrawaddy teak, though the average percentage of moisture only varied 5 per cent., the figures stood relatively high, the average for the *plantation* teak being 25 per cent., for the *natural* Fire-protected teak 20 per cent., and for the teak from Unclassed forest 23 per cent. Why the girdled teak in Tharrawaddy contained, after having been gridled for 3 years, so high a percentage of moisture it is difficult to say. In some ways it is to be regretted that it was not allowed to season further before being tested; on the other hand, it is interesting to compare the strength of the fully seasoned timber from Zigon with the partially seasoned timber from Tharrawaddy. It might be said with some justice that owing to the tests having been carried out with partially seasoned timber from Tharrawaddy, that that portion of the experiment was not conclusive. On the other hand, the object of these experiments was to compare the relative strength of *plantation* and *natural-grown* timber, and as the percentage of moisture, though high, was approximately equal in all three varieties of timber from Tharrawaddy, it is maintained that the comparisons remain correct.

Lastly, in order that the experiments should be carried out in every way under similar conditions, the specimens to be tested were cut to a standard size throughout. For shearing tests the size was $4'' \times 2'' \times 1''$, in the case of the compression tests they were $4'' \times 4'' \times 2''$, while in the case of the Zigon specimens the pieces tested for transverse strain were $26'' \times 2'' \times 2''$, and in the case of the Tharrawaddy specimens, $40'' \times 4'' \times 4''$.

IV.—Form in which the Results are given and the Method of Calculating the Co-efficient of Transverse Strength.

The results tabulated below are given in tons per square inch, the formula used being as follows :—

$$P = \frac{M \times Y}{I}$$

where $M = \frac{W \times L}{4}$ and $I = \frac{B \times D}{12}$

$$\therefore P = \frac{W \times L \times D \times 12}{2\ B \times D^3 \times 4} = \frac{3}{2} \frac{W \times L}{B \times D^2}$$

W being the weight in tons required to break a bar of given size, L the length in inches between supports, $Y = \frac{1}{2}$ D where D=the depth of the bar in inches, while B=breadth of bar in inches.

V.—Results Obtained.

(*i*) Plains-grown teak.

The following are the results obtained by testing *plantation* and *natural-grown* Plains teak, obtained from the Zigon Division.

NATURAL-GROWN PLAINS TEAK FROM ZIGON DIVISION.					PLANTATION-GROWN PLAINS TEAK FROM ZIGON DIVISION.				
RESULTS OF SHEARING TESTS ALONG THE GRAIN, IN TONS PER SQ. INCH.					RESULTS OF SHEARING TESTS ALONG THE GRAIN, IN TONS PER SQ. INCH.				
Size of specimen piece tested.	No. of specimen.	Actual weight applied in tons.	Tons per sq. inch.	Percentage of moisture in the wood at time of testing.	Size of specimen piece tested.	No. of specimen.	Actual weight applied in tons.	Tons per sq. inch.	Percentage of moisture in the wood at time of testing.
2″ × 1″, two surfaces of cleavage occurring in each specimen tested.	1	3·75	·937	12·13	2″ × 1″, two surfaces of cleavage occurring in each specimen tested.	1	2·50	·625	12·14
	2	3·61	·902			2	2·88	·720	
	3	2·74	·685	12·06		3	2·52	·630	
	4	2·37	·592			4	2 25	·562	13·05
	5	2·84	·710	12·06		5	2·53	·632	
	6	2·57	·642			6	2·34	·585	
	7	2·02	·505	13·21					
	8	2·94	·735						
	9	3·05	·762	12·34					
	10	2·85	·712						
	Average tons per sq. inch.		·718			Average tons per sq. inch.		·626	

The above results show the *natural-grown* teak as ·092 tons per square inch stronger than the *plantation-grown* product, a negligible quantity.

NATURAL-GROWN PLAINS TEAK FROM ZIGON DIVISION.

RESULTS OF COMPRESSION TESTS ALONG THE GRAIN, IN TONS PER SQ. INCH.

Size of specimen piece tested	No. of specimen.	Actual weight applied in tons.	Tons per sq. inch.	Percentage of moisture in the wood at time of testing.
4″ × 2″ × 2″	1	10·74	2·68	12·13
	2	10·44	2·61	
	3	9·94	2·48	12·06
	4	9·80	2·45	
	5	12·40	3·10	12·06
	6	12·00	3·00	
	7	12·43	3·11	13·21
	8	12·80	3·20	
	9	12·89	3·22	12·34
	10	12·43	3·11	
Average tons per sq. inch.			2·89	

PLANTATION-GROWN PLAINS TEAK FROM ZIGON DIVISION.

RESULTS OF COMPRESSION TESTS ALONG THE GRAIN, IN TONS PER SQ. INCH.

Size of specimen piece tested.	No. of specimen.	Actual weight applied in tons.	Tons per sq. inch.	Percentage of moisture in the wood at time of testing.
4″ × 2″ × 2″	1	11·56	2·89	12·14
	2	11·88	2·97	
	3	12·20	3·05	
	4	8·80	2·20	13·05
	5	10·40	2·60	
	6	9·65	2·41	
Average tons per sq. inch.			2·69	

As was the case with the shearing tests the *natural-grown* teak shows a slight excess in strength of ·20 of a ton over the *plantation-grown* product.

NATURAL-GROWN PLAINS TEAK FROM ZIGON DIVISION.					PLANTATION-GROWN PLAINS TEAK FROM ZIGON DIVISION.				
RESULTS OF TESTS FOR TRANSVERSE STRAIN ACROSS THE FIBRE, IN TONS PER SQ. INCH.					RESULTS OF TESTS FOR TRANSVERSE STRAIN ACROSS THE FIBRE, IN TONS PER SQ. INCH.				
Size of specimen piece tested.	No. of specimen.	Actual weight applied in tons.	Tons per sq. inch.	Percentage of moisture in the wood at time of testing.	Size of specimen piece tested.	No. of specimen.	Actual weight applied in tons.	Tons per sq. inch.	Percentage of moisture in the wood at time of testing.
26″ × 2″ × 2″ between centres of rockers. Pressure applied at centre of bar.	1	1·33	6·48	12·13	26″ × 2″ × 2″ between centres of rockers. Pressure applied at centre of bar.	1	1·55	7·56	12·14
	2	1·39	6·78			2	1·69	8·24	
	3	1·60	7·80	12·06		3	1·50	7·31	
	4	1·45	7·07			4	1·42	6·92	13·05
	5	1·52	7·41	12·06		5	1·35	6·58	
	6	1·39	6·78			6	1·30	6·34	
	7	1·32	6·43	13·21					
	8	1·38	6·73						
	9	1·78	8·68	12·34					
	10	1·62	7·90						
Average tons per sq. inch.			7·21		Average tons per sq. inch.			7·16	

Tests for transverse strain are more important than either those for compression or shearing, as in the majority of cases timber is subjected to transverse forces. In this case, as in the other tests, the *natural-grown* product proved itself slightly superior to the *plantation-grown* teak, the difference being ·05 of a ton per square inch.

(*ii*) Hill-grown teak.

NATURAL-GROWN HILL TEAK FROM ZIGON DIVISION.					PLANTATION-GROWN HILL TEAK FROM ZIGON DIVISION.				
RESULTS OF SHEARING TESTS ALONG THE GRAIN, IN TONS PER SQ. INCH.					RESULTS OF SHEARING TESTS ALONG THE GRAIN, IN TONS PER SQ. INCH.				
Size of specimen piece tested.	No. of specimen.	Actual weight applied in tons.	Tons per sq. inch.	Percentage of moisture in the wood at time of testing.	Size of specimen piece tested.	No. of specimen.	Actual weight applied in tons.	Tons per sq. inch.	Percentage of moisture in the wood at time of testing.
2″ × 1″, two surfaces of cleavage occurring in each specimen tested.	1	2·84	·710	10·81	2″ × 1″, two surfaces of cleavage occurring in each specimen tested.	1	2·02	·505	11·78
	2	3·01	·752			2	2·38	·595	
	3	3·38	·845	12·46		3	3·11	·778	12·61
	4	3·54	·885			4	2·94	·735	
	5	2·79	·697	10·95		5	2·06	·515	10·80
	6	2·56	·640			6	2·37	·592	
	7	2·75	·687	10·97		7	3·01	·752	11·28
	8	3·04	·760			8	3·19	·797	
	9	2·50	·625	11·04		9	3·08	·770	11·86
	10	3·03	·757			10	2·74	·685	
Average tons per sq. inch.			·736		Average tons per sq. inch			·672	

As was the case with the shearing tests of *plains-grown* teak, the *natural-grown* product proved itself stronger than the *plantation-grown* teak, the difference again being very small, namely ·064 tons per square inch.

NATURAL-GROWN HILL TEAK FROM ZIGON DIVISION.					PLANTATION-GROWN HILL TEAK FROM ZIGON DIVISION.				
RESULTS OF COMPRESSION TESTS ALONG THE GRAIN, IN TONS PER SQ. INCH.					RESULTS OF COMPRESSION TESTS ALONG THE GRAIN, IN TONS PER SQ. INCH.				
Size of specimen piece tested.	No. of specimen.	Actual weight applied in tons.	Tons per sq. inch.	Percentage of moisture in the wood at time of testing.	Size of specimen piece tested.	No. of specimen.	Actual weight applied in tons.	Tons per sq. inch.	Percentage of moisture in the wood at time of testing.
4″ × 2″ × 2″	1	13·12	3·28	10·81	4″ × 2″ × 2″	1	9·90	2·47	11·78
	2	13·19	3·30			2	11·32	2·83	
	3	10·50	2·62	12·46		3	13·19	3·30	12·61
	4	9·30	2·32			4	12·75	3·19	
	5	10·15	2·54	10·95		5	12·44	3·11	10·80
	6	8·78	2·19			6	11·59	2·90	
	7	11·39	2·85	10·97		7	15·06	3·76	11·28
	8	12·80	3·20			8	14·06	3·51	
	9	12·20	3·05	11·04		9	13·31	3·33	11·86
	10	12·68	3·17			10	12·40	3·10	
Average tons per sq. inch.			2·85		Average tons per sq. inch.			3·15	

In the case of Compression tests for *plains-grown* teak, the *natural-grown* timber showed itself slightly stronger than the *plantation-grown*

product. Here it is the reverse, the difference being ·30 tons per square inch in favour of the latter.

NATURAL-GROWN HILL TEAK FROM ZIGON DIVISION.					PLANTATION-GROWN HILL TEAK FROM ZIGON DIVISION.				
RESULTS OF TESTS FOR TRANSVERSE STRAIN ACROSS THE FIBRE, IN TONS PER SQ. INCH.					RESULTS OF TESTS FOR TRANSVERSE STRAIN ACROSS THE FIBRE, IN TONS PER SQ. INCH.				
Size of specimen piece tested.	No. of specimen.	Actual weight applied in tons.	Tons per sq. inch.	Percentage of moisture in the wood at time of testing.	Size of specimen piece tested.	No. of specimen.	Actual weight applied in tons.	Tons per sq. inch.	Percentage of moisture in the wood at time of testing.
26″ × 2″ × 2′ between centres of rockers. Pressure applied at centre of bar.	1	1·43	6·97	10·81	26″ × 2″ × 2′ between centres of rockers. Pressure applied at centre of bar.	1	1·06	5·17	11·78
	2	1·61	7·85			2	1·08	5·26	
	3	1·21	5·90	12·46		3	1·99	9·70	12·61
	4	1·29	6·29			4	1·95	9·50	
	5	1·45	7·07	10·95		5	1·59	7·75	10·80
	6	1·59	7·75			6	1·54	7·50	
	7	1·43	6·97	10·97		7	1·33	6·48	11·28
	8	1·64	7·99			8	1·77	8·63	
	9	1·51	7·36	11·04		9	1·50	7·31	11·86
	10	1·61	7·85			10	1·66	8·09	
Average tons per sq. inch.			7·20	...	Average tons per sq. inch.			7·54	.....

Here again we find the *plantation-grown* Hill teak slightly stronger by ·34 tons per square inch than that grown in *natural forests*, though as was the case with all other tests the variations either way are insignificant.

The following are the results obtained by testing teak specimens from trees grown in *plantations*, in *natural fire-protected* and in *natural non-fire protected* forests of the Tharrawaddy Division :—

NATURAL-GROWN TEAK FROM FIRE-PROTECTED FORESTS OF THE THARRAWADDY DIVISION.

RESULTS OF SHEARING TESTS ALONG THE GRAIN, IN TONS PER SQ. INCH.

Size of specimen piece tested.	No. of specimen.	Average of two pieces. Actual weight applied in tons.	Tons per sq. inch.	Percentage of moisture in wood at time of testing.
2″ × 1″, two surfaces of cleavage occurring in each specimen tested.	1	3·31	·827	16
	2	3·50	·875	20
	3	2·75	·687	24
	4	2·81	·702	19
	Average ·773 tons per sq. inch.			

NATURAL-GROWN TEAK FROM NON-FIRE-PROTECTED FORESTS OF THE THARRAWADDY DIVISION.

RESULTS OF SHEARING TESTS ALONG THE GRAIN, IN TONS PER SQ. INCH.

Size of specimen piece tested.	No. of specimen.	Average of two pieces. Actual weight applied in tons.	Tons per sq. inch.	Percentage of moisture in wood at time of testing.
2″ × 1″, two surfaces of cleavage occurring in each specimen tested.	1	2·58	·645	26
	2	3·14	·785	18
	3	2·96	·740	28
	4	2·62	·655	23
	Average ·706 tons per sq. inch.			

PLANTATION-GROWN TEAK FROM FIRE-PROTECTED FORESTS OF THE THARRAWADDY DIVISION.

RESULTS OF SHEARING TESTS ALONG THE GRAIN, IN TONS PER SQ. INCH.

Size of specimen piece tested.	No. of specimen.	Average of two pieces. Actual weight applied in tons.	Tons per sq. inch.	Percentage of moisture in wood at time of testing.
2″ × 1″, two surfaces of cleavage occurring in each specimen tested.	1	3·51	·878	31
	2	3·31	·828	23
	3	2·09	·522	26
	4	3·24	·810	22
	Average tons per sq. inch. ·759			

The above three sets of figures vary little, the *natural-grown fire-protected teak* showing the greatest resistance to shearing forces, it being ·067 tons per square inch in excess of the *natural non-fire-protected* variety, and ·140 tons per square inch above that of the *plantation-grown* timber. In all cases the percentage of moisture in the timber was relatively high, averaging 20 per cent. in the *natural-grown fire-protected*, 23 per cent. in the *natural-grown non-fire-protected*, and 25 per cent. in the *plantation-grown* teak.

NATURAL-GROWN TEAK FROM FIRE-PROTECTED FORESTS OF THE THARRAWADDY DIVISION

RESULTS OF COMPRESSION TESTS ALONG THE GRAIN, IN TONS PER SQ. INCH.

Size of specimen piece tested.	No. of specimen.	Average of two pieces. Actual weight applied in tons.	Tons per sq. inch.	Percentage of moisture in wood at time of testing.
4″ × 2″ × 2″	1	13·28	3·32	16
	2	11·16	2·79	20
	3	13·55	3·39	24
	4	13·83	3·46	19
Average tons per sq. inch.			3·24	

NATURAL-GROWN TEAK FROM NON-FIRE-PROTECTED FORESTS OF THE THARRAWADDY DIVISION.

RESULTS OF COMPRESSION TESTS ALONG THE GRAIN, IN TONS PER SQ. INCH.

Size of specimen piece tested.	No. of specimen.	Average of two pieces. Actual weight applied in tons.	Tons per sq. inch.	Percentage of moisture in wood at time of testing.
4″ × 2″ × 2″	1	12·26	3·06	26
	2	13·20	3·30	18
	3	14·90	3·72	26
	4	12·74	3·18	23
Average tons per sq. inch.			3·31	

PLANTATION-GROWN TEAK FROM FIRE-PROTECTED FORESTS OF THE THARRAWADDY DIVISION.

RESULTS OF COMPRESSION TESTS ALONG THE GRAIN, IN TONS PER SQ. INCH.

Size of specimen piece tested.	No. of specimen.	Average of two pieces. Actual weight applied in tons.	Tons per sq. inch.	Percentage of moisture in wood at time of testing.
4″ × 2″ × 2″	1	13·46	3·36	31
	2	11·86	2·96	23
	3	13·18	3·29	26
	4	14·00	3·50	22
Average tons per sq. inch.			3·28	

The variations in strength of all three sets of experiments are so small they may all be classed as practically equal. The remarks made in the above paragraph about the percentage of moisture in the timber apply with equal force to this set of tests.

NATURAL-GROWN TEAK FROM FIRE-PROTECTED FORESTS OF THE THARRAWADDY DIVISION.

RESULTS OF TESTS FOR TRANSVERSE STRAIN ACROSS THE FIBRE, IN TONS PER SQ. INCH.

Size of specimen piece tested.	No. of specimen.	Average of two pieces. Actual weight applied in tons.	Tons per sq. inch.	Percentage of moisture in wood at time of testing.
40″ × 4″ × 4′ between centres of rockers. Pressure applied at centre of bar.	1	7·07	6·63	16
	2	4·55	4·26	20
	3	5·53	5·18	24
	4	5·53	5·18	19

Average tons per sq. inch. 5·31

NATURAL-GROWN TEAK FROM NON-FIRE-PROTECTED FORESTS OF THE THARRAWADDY DIVISION.

RESULTS OF TESTS FOR TRANSVERSE STRAIN ACROSS THE FIBRE, IN TONS PER SQ. INCH.

Size of specimen piece tested.	No. of specimen.	Average of two pieces. Actual weight applied in tons.	Tons per sq. inch.	Percentage of moisture in wood at time of testing.
40″ × 4″ × 4′ between centres of rockers. Pressure applied at centre of bar.	1	5·62	5·27	26
	2	5·38	5·04	18
	3	6·52	6·11	26
	4	4·50	4·22	23

Average tons per sq. inch . 5·16

PLANTATION-GROWN TEAK FROM FIRE-PROTECTED FORESTS OF THE THARRAWADDY DIVISION.

RESULTS OF TESTS FOR TRANSVERSE STRAIN ACROSS THE FIBRE, IN TONS PER SQ. INCH.

Size of specimen piece tested.	No. of specimen.	Average of two pieces. Actual weight applied in tons.	Tons per sq. inch.	Percentage of moisture in wood at time of testing.
40″ × 4″ × 4″ between centres of rockers. Pressure applied at centre of bar.	1	5·57	5·22	31
	2	5·56	5·21	23
	3	5·63	5·28	26
	4	5·49	5·15	22

Average tons per sq. inch. 5·21

It is interesting to note the marked uniformity of the above results; the figures vary so little in each set of tests that the conclusion arrived at is that one variety of timber is in all ways equal in strength to the other. A point worthy of notice in the above set of figures, when taken as a whole, is that the average transverse strength of the Tharrawaddy timber is only a little over 5 tons per square inch, as against an average of 7 tons per square inch for the Zigon teak. The reasons for this variation will be discussed hereafter.

VI.—Comparison of Past and Present Results.

(*i*) *Shearing Tests.*

It is of interest to compare the results of tests carried out in the past with those obtained more recently. To do so clearly it is necessary to tabulate the results, so as to be able to take in the position of affairs at a glance. The following are some of the tests carried out for the **Shearing** strength of teak in recent years.

Variety of timber tested and locality from which it was obtained.	The date of, the place at which, and the name of the person who carried out the tests.	Shearing strength along the grain, in tons per sq. inch.	Percentage of moisture in the wood at the time of testing.
Natural-grown teak . .	Sibpur Engineering College, 1906. Professor Everett.	·592	Not known.
Natural-grown teak from the Zigon Division.	Sibpur Engineering College, 1910. G. R. Ballantine, Foreman Instructor.	·653	9·89 per cent.
Plantation-grown teak from the Zigon Division.	Sibpur Engineering College, 1910. R. S. Pearson.	·857	10·83 per cent.
Natural-grown Plains teak from the Zigon Division.	Sibpur Engineering College, 1912. G. R. Ballantine, Foreman Instructor.	·718	12·06 per cent. to 13·21 per cent.

Variety of timber tested and locality from which it was obtained.	The date of, the place at which, and the name of the person who carried out the tests.	Shearing strength along the grain, in tons per sq. inch.	Percentage of moisture in the wood at the time of testing.
Plantation-grown Plains teak from the Zigon Division.	Sibpur Engineering College, 1912. G. R. Ballantine, Foreman Instructor.	·626	12·14 per cent. to 13·05 per cent.
Natural-grown Hill teak from the Zigon Division.	Do. do.	·736	10·81 per cent. to 12·46 per cent.
Plantation-grown Hill teak from the Zigon Division.	Do. do.	·672	10·80 per cent. to 12·61 per cent.
Natural-grown teak from Fire-protected forest in the Tharrawaddy Division.	Do. do.	·773	16 per cent. to 24 per cent.
Natural-grown teak from Non-fire-protected forest in the Tharrawaddy Division.	Do. do.	·706	18 per cent. to 26 per cent.
Plantation-grown teak from Fire-protected forest, in the Tharrawaddy Division.	Do. do	·759	22 per cent. to 31 per cent.

Before making any comparison it must be remembered that the above figures represent the averages of many specimens tested. From the above table it will be seen that the highest figure recorded is for *plantation-grown* teak, next in order come two *natural-grown* specimens, after that the results of both varieties of timber are very similar, the first figure shown on the list being as low as ·592 tons per square inch, which was the result of tests carried out on *natural-grown* timber. A point of special interest is that the moisture in the timber appears to have little or no effect on its **shearing** strength, as in some cases it was as low as 10 per cent. while in others as high as 31 per cent., while the strength of the timber remained unimpaired.

(*ii*) *Compression Tests.*

Turning to tests for **Compression** the information available is even more complete than in the case of the **Shearing** tests. The following are some of the results which are to hand of tests carried out in recent years :—

Variety of timber tested and locality from which it was obtained.	The date of, the place at which, and the name of the person who carried out the tests.	Compression tests along the grain, in tons per sq. inch.	Percentage of moisture in the wood at the time of testing.
1. Teak from Prome Plantations of 1861.	Sibpur Engineering College, 1904. Professor Everett. Average of 10 specimens.	2·54	Not known.
2. Teak from Prome Plantations of 1860.	Do. do.	2·55	Do.
3. Natural teak, from Burma, locality unknown.	Do. do.	3·03	Do.
4. Natural-grown teak, from Pegu.	Sibpur Engineering College in 1906. Average of 4 specimens.	3·02	Do.
5. Natural-grown teak, from the Zigon Division.	Sibpur Engineering College, 1910. G. R. Ballantine, Foreman Instructor. Average of 30 specimens.	3·014	9·89 per cent.
6. Plantation-grown teak, from the Zigon Division.	Sibpur Engineering College, 1911. R. S. Pearson. Average of 8 specimens.	3·707	10·83 per cent.
7. Natural-grown Plains teak, from the Zigon Division.	Sibpur Engineering College, 1912. G. R. Ballantine, Foreman Instructor. Average of 10 specimens.	2·89	12·06 per cent. to 13·21 per cent.
8. Plantation-grown Plains teak, from the Zigon Division.	Sibpur Engineering College, 1912. G. R. Ballantine, Foreman Instructor. Average of 6 specimens.	2·69	12·14 per cent. to 13·05 per cent.

Variety of timber tested, and locality from which it was obtained.	The date of, the place at which, and the name of person who carried out the tests.	Compression tests along the grain, in tons per sq. inch.	Percentage of moisture in the wood at the time of testing.
9. Natural-grown Hill teak from the Zigon Division.	Sibpur Engineering College, 1912. G. R. Ballantine, Foreman Instructor. Average of 10 specimens.	2·85	10·81 per cent. to 12·46 per cent.
10. Plantation-grown Hill teak, from the Zigon Division.	Sibpur Engineering College, 1912. G. R. Ballantine, Foreman Instructor. Average of 10 specimens.	3·15	10·80 per cent. to 12·61 per cent.
11. Natural-grown teak, from Fire-protected areas of the Tharrawaddy Division.	Sibpur Engineering College, 1912. G. R. Ballantine, Foreman Instructor. Average of 8 specimens .	3·24	16 per cent. to 24 per cent.
12. Natural-grown teak, from Non-fire-protected areas of the Tharrawaddy Division.	Sibpur Engineering College, 1912. G. R. Ballantine, Foreman Instructor. Average of 8 specimens .	3·31	18 per cent. to 26 per cent.
13. Plantation-grown teak, from Fire-protected areas of the Tharrawaddy Division.	Sibpur Engineering College, 1912. G. R. Ballantine, Foreman Instructor. Average of 8 specimens .	3·28	22 per cent. to 31 per cent.

Thirteen sets of tests to ascertain the strength of teak to withstand compression have been carried out in recent years, of which records are available, while the total number of specimens tested was 132. It is considered that this is a sufficient number on which to form a very fair opinion of the relative strength of the *plantation* and *natural-grown* varieties. Of the thirteen sets of figures, eight show the resistance of teak to compression to be over 3 tons per square inch, of these five are *natural* and three of *plantation-grown* timber. The highest record is 3·707 tons to the square inch, a result obtained by testing *plantation-grown* teak from the Zigon Division. The variations in strength differ little; even by taking the maximum and minimum figures the difference is only 1·167 tons, while the average for both varieties is only ·025 tons per square inch in favour of the *plantation-grown* product. For all

intents and purposes the two varieties of teak may be said to be equal, as far as their strength to withstand compression is concerned.

(*iii*) *Tests for Transverse Strength.*

Without a doubt the most important factor in the strength of timber is to withstand **Transverse** strain. Gamble in his *Manual of Indian Timbers* gives numerous figures for the co-efficient of **Transverse** strength of teak, a few cases of which were quoted in the previous note on this subject: for further data of past record his manual may be consulted. The results of the more recent tests for **Transverse** strength are given below:—

Varieties of timber tested and locality from which it was obtained.	The date of, the place at which, and the name of the person who carried out the tests.	Transverse strength across the grain, in tons per sq. inch.	Percentage of moisture in the wood at the time of testing.
1. Natural-grown teak, from Pegu.	Sibpur Engineering College, 1906. Professor Everett. Average of 4 specimens.	4·53	Not known.
2. Natural-grown teak, from the Zigon Division.	Sibpur Engineering College, 1910. G. R. Ballantine, Foreman Instructor. Average of 30 specimens.	7·77	9·89 per cent.
3. Plantation-grown teak, from the Zigon Division. Pressure applied tangentially to fibre.	Sibpur Engineering College, 1910. R. S. Pearson. Average of 8 specimens.	7·73	10·83 per cent.
4. Plantation-grown teak, from the Zigon Division. Pressure applied radially to fibre.	Sibpur Engineering College, 1910. R. S. Pearson. Average of 7 specimens.	6·91	10·83 per cent.
5. Natural-grown Plains teak, from the Zigon Division.	Sibpur Engineering College, 1910. G. R. Ballantine, Foreman Instructor. Average of 10 specimens.	7·21	12·06 per cent. to 13·21 per cent.
6 Plantation-grown Plains teak, from the Zigon Division.	Sibpur Engineering College, 1910. G. R. Ballantine, Foreman Instructor. Average of 6 specimens	7·16	12·14 per cent. to 13·05 per cent.

Variety of timber tested and locality from which it was obtained.	The date of, the place at which, and the name of the person who carried out the tests.	Transverse strength across the grain, in tons per sq. inch.	Percentage of moisture in the wood at time of testing.
7. Natural-grown Hill teak, from the Zigon Division.	Sibpur Engineering College, 1912. G. R. Ballantine, Foreman Instructor. Average of 10 specimens.	7·20	10·81 per cent. to 12·46 per cent.
8. Plantation-grown Hill teak, from the Zigon Division.	Sibpur Engineering College, 1912. G. R. Ballantine, Foreman Instructor. Average of 10 specimens.	7·54	10·80 per cent. to 12·61 per cent.
9. Natural-grown teak from Fire-protected forest of the Tharrawaddy Division.	Sibpur Engineering College, 1912. G. R. Ballantine, Foreman Instructor. Average of 4 specimens, 1911.	5·31	16 per cent. to 24 per cent.
10. Natural-grown teak, from Non-fire-protected forests of the Tharrawaddy Division.	Sibpur Engineering College, 1912. G. R. Ballantine, Foreman Instructor. Average of 4 specimens, 1911.	5·16	18 per cent. to 26 per cent.
11. Plantation-grown teak from Fire-protected forests of the Tharrawaddy Division.	Sibpur Engineering College, 1912. G. R. Ballantine, Foreman Instructor. Average of 4 specimens, 1911.	5·21	22 per cent. to 31 per cent.

When glancing at column 3, the first point that strikes one is the large variation in the figures for the transverse strength of the Zigon and Tharrawaddy teak. In the case of the Zigon teak both *plantation* and *natural-grown*, with one single exception, show a strength of over 7 tons per square inch, while the strength of the Tharrawaddy teak is roughly two tons per square inch below that of the Zigon timber. This is a very considerable difference and one which requires some explanation. In the writer's opinion it has nothing to do with the quality of the timber, which was inspected at Sibpur before it was tested, but with the percentage of moisture in the timber at the time of testing. The percentage of moisture in the Zigon teak at the time it was tested was between 9·89 per cent. and 13·21 per cent., while the percentage of moisture in the Tharrawaddy timber varied between 16 per cent. and 31 per cent., the

average being well over 20 per cent. In the previous note on the subject, attention was repeatedly drawn to the amount of moisture in the timber with reference to its **Transverse** strength, though the results of tests at that time available were hardly sufficient to justify any conclusions being drawn in this connection. The figures obtained from the more recent tests go far to confirm the theory that highly seasoned is stronger than partially seasoned timber, especially as the results of testing the Zigon and Tharrawaddy teak in themselves give very consistent results for each class of timber.

VII—Conclusions.

The object with which these experiments were carried out was to ascertain whether the *plantation-grown* teak was as strong as that from *natural forests*. The answer is without doubt in the affirmative.

Another point of interest is that from the figures for **Compression** and **Shearing** tests it appears that the percentage of moisture in the timber has no marked effect on the strength of teak, whereas it appears to have a considerable effect when **Transverse** strain is applied to the timber, across the fibre.

It was thought that possibly the strength of girdled teak might differ from that of teak felled green and afterward seasoned in the log. In the tests carried out by the writer in 1910 the *plantation-grown* teak was felled green while the *natural-grown* teak was felled after having been girdled for three years. Again of the ten plantation logs cut in compartment 4 of the Kadin Bilin Reserve, in the Tharrawaddy Division, five were girdled and felled three years later, while five girdled trees were cut by mistake in the following year. It is of interest to compare the results obtained by testing these two varieties of timber for **Transverse** strength.

	Variety of, and locality from which the timber was obtained.	Average **Transverse** strin across the fibre, in tons per sq. inch.
Felled in adjoining forests.	Plantation-grown teak felled green and afterwards seasoned, from the Zigon Division.	7·32
	Natural-grown teak girdled and felled three years later, from the Zigon Division.	7·77

	Variety of, and locality from which the timber was obtained.	Average **Transverse** strain across the fibre, in tons per sq inch.
Felled in the same forest.	Plantation-grown teak felled green and afterwards seasoned, from the Tharrawaddy Division.	5·17
	Plantation-grown teak girdled and felled three years afterwards, from the Tharrawaddy Division.	5·21

From the above two sets of figures it is perfectly clear that there is practically no difference in the strength of timber seasoned standing and when felled and seasoned in the log.

It is necessary to make one further point clear with regard to the tests the results of which are recorded above, and that is that the greatest care was taken by the forest officers who supplied the timber to do so from the trees of equal age. An objection was made to the former set of experiments published in *Forest Bulletin* No. 3 of 1911 in this respect; however, by comparisons of the past and present results it will be seen that the criticism was premature, as the results are practically identical in every case, the variations in strength being negligible.

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Forest Bulletin No. 15 1913

Note on the Technical Properties of Timber

With Special Reference to *Cedrela Toona* Wood while Seasoning

BY

R. S. PEARSON, F.L.S.,
Imperial Forest Service, Economist at the Forest Research Institute, Dehra Dun, India

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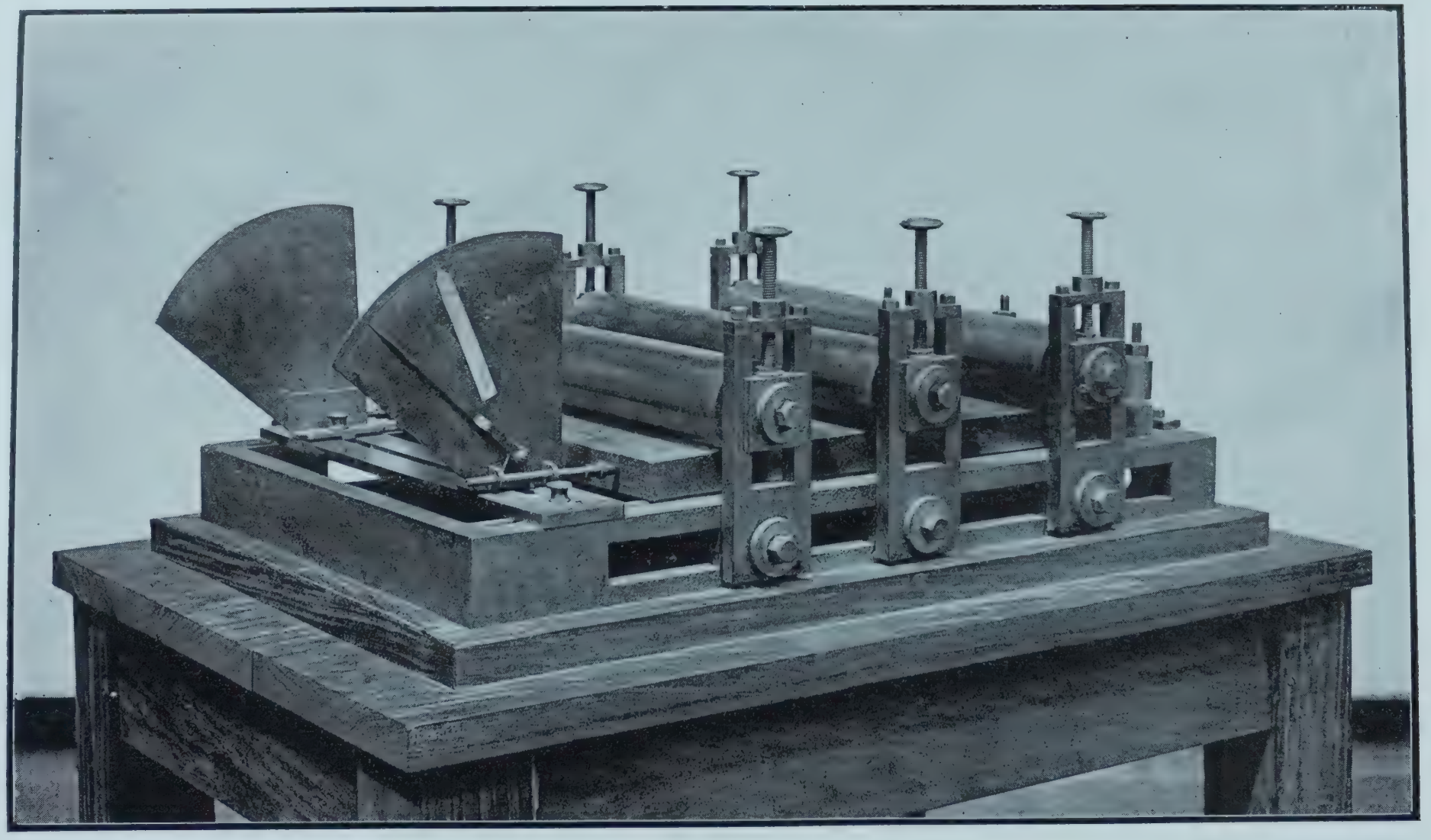


Photo.-Mechl. Dept. Thomason College, Roorkee. Photo. by T. B. Chitrakar.

MACHINE FOR TESTING EXPANSION AND CONTRACTION OF TIMBER.

Note on the Technical Properties of Timber

With Special Reference to *Cedrela Toona* Wood while Seasoning.

By R. S. PEARSON, F.L.S.,

Imperial Forest Service.
Economist at the Forest Research Institute,
Dehra Dun, India.

1. Object of these Experiments.

THE object of this set of experiments, the first of which is recorded below, was to ascertain the relative amount of shrinkage which takes place in different species of timber while seasoning. This is a most important point and one of special interest in India, where the system of utilizing unseasoned timber largely prevails, especially amongst native carpenters. The evil effects of this practice are only too well known; for instance, joints gape in the hot weather and fill up again during the rains, doors do not shut properly or cause draughts due to their not fitting, while similar inconveniences without number might be mentioned in this connection.

In order to demonstrate more fully this tendency on the part of certain timbers to contract and to again expand with variations of moisture and temperature, the first species chosen on which to experiment was *Cedrela Toona*, the Toon Wood of commerce, largely used for furniture-making in Northern India. It is well known that while Toon timber contracts to a great extent while seasoning and also has a tendency to warp, it does not crack to any great extent.

2. The Testing Machine.

In order to carry out these experiments a new machine had to be devised in which to test the timber. Mr. Heaton, Principal of the Civil Engineering College, Sibpur, was consulted on the subject and under his directions a machine was made under the supervision of Mr. Ballantine, Foreman-Instructor, which has answered the purpose admirably. The

picture of this machine is given as a frontispiece. It consists of a solid basal frame made of gun metal, 23 inches long, 15 inches in breadth and 3 inches deep (outside measurements). At the one end is a moveable clamping plate, supported by three upright bolts, fitted with screws and nuts, so that on the specimen-board being placed beneath it, it can be firmly screwed down to hold the plank rigidly in position.

The sides of the frame are groved, supporting the brackets to which the bearings carrying the three sets of rollers are attached. All six rollers are of the same size, being $3\frac{3}{16}$ inches in diameter. The upper three rollers are, as stated above, fixed to brackets, the bearings of which can be raised or lowered by means of screws. This is necessary in order that a plank of any reasonable thickness can be placed in the machine, and the rollers be screwed down so as to bear on its surface.

Further, any one set of rollers can be removed at pleasure, so as to take a plank of greater or less breadth.

At the opposite end to which the clamp-block is fixed are two dials, to which are attached pointers, each bearing on a small shaft to which springs are fitted, the dials being divided into divisions of $\frac{1}{200}$th of an inch. These dials are supported by a groved plate, the whole being moveable backwards or forwards, and at the same time the dials are fitted with clamps attached to the plate so that they too can be moved nearer or further apart as necessary.

In order to fix a plank in position for the purpose of testing, after being cut accurately to size, one end is placed under the clamp-block, which is tightly screwed down, and the upper three rollers are then brought down so as to bear on the upper surface of the board, care being taken that the under-surface is also in contact with the lower set of rollers. The bearing plates supporting the dial-shafts, to which the pointers are connected, are then moved along so that the tips of the shafts touch the end of the board, the needles on both dials pointing to zero.

The three sets of double rollers are necessary to prevent any tendency on the part of the plank to warp and at the same time to allow the wood to expand or contract without excessive friction taking place.

In order to eliminate all chances of error due to shrinkage or expansion of the gun metal, of which the machine is constructed, marks were made on one side of the frame and a standard rod used with which to detect any possible tendency on the part of the frame to vary in size with variations of temperature.

3. Description of the Plank tested.

As before stated the plank tested was of *Cedrela Toona,* cut from a tree felled in the Forest College ground at Dehra Dun. The tree was felled on the 11th November 1910, the plank was prepared at once and put in the testing machine on the following day. It was therefore an absolutely green piece of wood, the percentage of moisture in it on the 12th November 1910, according to the Forest Chemist's analysis, was 51·21 per cent.

The board was one inch thick and 13 inches long. These two dimensions may be treated as constants, as though the plank no doubt shrunk slightly in thickness this did not affect the readings of lateral contraction, nor would the length of the plank come into consideration as the shrinkage of timber along the fibre is negligible. The important dimension to which this experiment refers, is the breadth of the plank, *i.e.,* across the fibre. The plank in question from the outer edge of the clamp-block to the dial-edge was 16·63 inches.

4. Results recorded.

Readings were taken from time to time, the records of which are tabulated below. In order to illustrate more clearly the movements of the plank during seasoning curves have been prepared, one demonstrating the contraction and expansion which took place, the other showing the percentage of moisture in the atmosphere on the dates on which the readings were taken.*

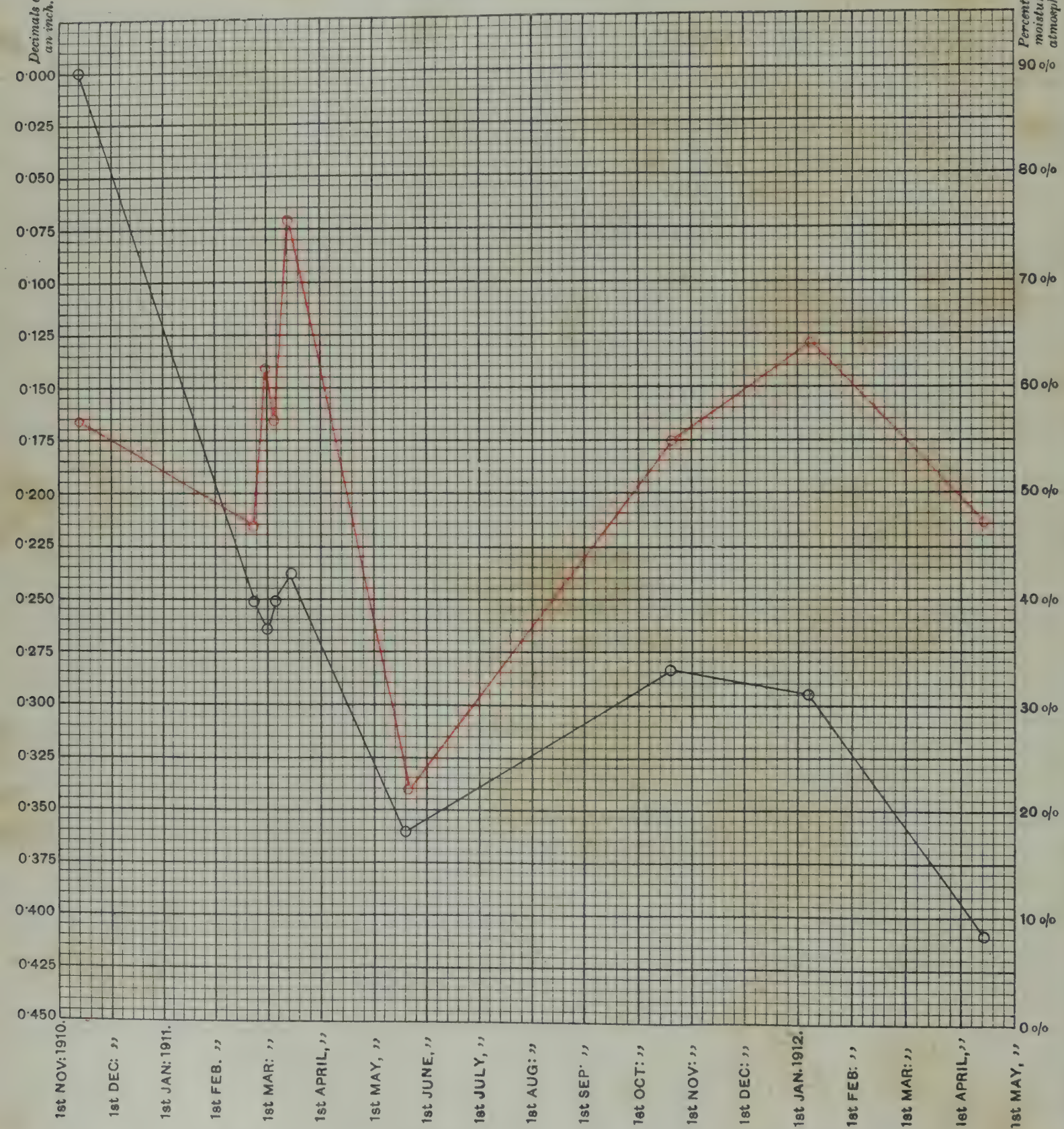
Date on which the readings were recorded.	Reading on dial A, in fractions of an inch.	Reading on dial B, in fractions of an inch.	Mean readings on A and B, in fractions of an inch.	Readings reduced to decimals of an inch and calculated on the contraction of a board one foot broad.	Variation, calculated on a board one foot broad.		Percentage of humidity in the air at		Percentage of moisture in the wood.	Remarks.
					Contraction in inches.	Expansion in inches.	10 A.M.	4 P.M.		
1	2	3	4	5	6		7		8	9
12th November 1910.	0	0	0	0	0	...	63	42	51·21 per cent.	Dry weather.
22nd February 1911.	$\frac{66''}{200}$	$\frac{75''}{200}$	$\frac{70·5''}{200}$	·252	·252	...	52	51	...	During February the weather was dry.

* The writer is indebted to Mr. J. deGraaff Hunter, Mathematical Expert, of the Great Trigonometrical Survey, for the moisture readings.

Date on which the readings were recorded.	Reading on dial A, in fractions of an inch.	Reading on dial B, in fractions of an inch.	Mean readings on A and B, in fractions of an inch.	Readings reduced to decimals of an inch and calculated on the contraction of a board one foot broad.	Variation, calculated on a board one foot broad.		Percentage of humidity in the air at		Percentage of moisture in the wood.	Remarks.
					Contraction in inches.	Expansion in inches.	10 A.M.	4 P.M.		
1	2	3	4	5	6		7		8	9
1st March 1911	69″/200	78″/200	73·5″/200	·265	·013	...	...	...	...	.....
2nd „ „	Not recorded.	Not recorded.	...	...	...	...	62	75	...	Rain began to fall on 2nd March.
4th „ „	66″/200	75″/200	70·5″/200	·252	...	·013	57	57	...	.....
12th „ „	Not recorded.	Not recorded.	...	...	..	...	82	94	...	It rained very heavily on the 10th, 11th, 12th and 13th of March.
13th „ „	62″/200	71″/200	66·5″/200	·239	...	·013	76	67	...	.....
18th May 1911 .	104″/200	103″/200	103·5″/200	·362	·123	...	22	13	...	Reading taken after a long period of continuous dry weather.
18th October 1911.	73″/200	85″/200	79″/200	·284	...	·078	55	51	...	End of the rains.
6th January 1912.	78″/200	86″/200	82″/200	·295	·011	...	64	53	...	.....
13th April 1912.	112″/200	115″/200	113·5″/200	·408	·013	...	47	33	...	After a long period of dry weather.
			Total . .		·512	·104				
			Total contraction .		·408	..				
23rd „ „	..	...	...	...	...	.	...	...	7·59 per cent.	.....

The point of greatest interest in the above figures is, that for the year and five months during which the plank was in the machine it contracted ·408 of an inch per foot across the grain, while the moisture in the timber was reduced from 51·21 per cent. to 7·59 per cent. The next point of interest can better be understood by referring to the curves showing graphically the movements of the wood in relation to the percentage of moisture in the air, than by studying the above table. Up to the 1st February 1911 there was dry weather, during which period

PEARSON—NOTE ON THE TECHNICAL PROPERTIES OF CEDRELA TOONA WOOD.



NOTE.—*The black curve represents the expansion and contraction of the Toon plank.*
The red ,, ,, ,, percentage of moisture in the atmosphere.
at 10 hours.

Photo.-Mechl. and Litho. Dept., Thomason College, Roorkee. No. 3267-1-1100

[To face page 5.

shrinkage steadily took place. On the 2nd March 1911 some rain fell and the atmosphere was moist, so that the readings on the 4th March showed the timber to have expanded. Heavy rain fell on the 10th, 11th, 12th and 13th of March, resulting in further expansion taking place. From that date onwards to the middle of May hot dry weather was experienced, with the result that the contraction which took place was considerable, the plank having been reduced ·362 of an inch per foot across the grain. The rains of 1911, however, again caused the timber to expand resulting in an increase in size of ·078 of an inch by the end of October, as compared with its dimensions in May 1911. From that time onward up till the last reading was taken in April 1912, it continued to contract to the total extent of ·408 of an inch per foot or over half inch on the total breadth of the plank, *i.e.*, 16·63 inch.

5. Conclusions.

It may be taken as an established fact that Toon timber, while seasoning, contracts very considerably, and that when seasoned it is very liable to absorb moisture and again expand. How long this process of expansion and contraction continues is not known. From general observations it is thought to continue for several years, though probably in each succeeding year, the variations are less marked. It will be seen that the specimen plank in question decreased nearly ·3 of an inch per foot in breadth from November 1910 to January 1912, in other words in little over a year, and that further contraction of about ·1 of an inch took place in the hot weather. At that period it was probably somewhere near the limit of its contraction, for the moisture in the timber was then only 7·59 per cent., in other words it was completely seasoned. The very fact that only 7·59 per cent. of moisture was found in the timber shows the facility with which Toon wood loses moisture, and it also probably indicates the facility with which it is again absorbed.

It is thought that the above test clearly shows the great necessity of seasoning *Cedrela Toona* as much as it is possible to do so, and the danger of this excellent furniture timber falling into disrepute simply for want of a little care in seasoning it before conversion. If converted when in a green state, the plank should be allowed to season for at least one year, and if seasoned in the log for 18 months to two years.

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NOTE ON GUMHAR

(*Gmelina arborea*, Roxb.)

BY

A. RODGER, I.F.S.

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Gumbár.

Gmelina arborea, Roxb.

Natural Order—Verbenaceae.

GUMHÁR.

Gmelina arborea, Roxb.

Natural Order—Verbenaceæ.

1. General Distribution.

This tree, although occurring over a large part of India, is nowhere plentiful, being more scattered probably than any other forest species of importance. It is most plentiful in Burma, becoming smaller in size and of less importance towards the west and north, so that in the United Provinces, Punjab, Bombay and Central Provinces, it is not reckoned as an important forest tree. Large supplies can only be expected from Burma, and smaller quantities from the Central Provinces and Assam where it attains a height of over 100 feet and a girth of 15 feet. In Ceylon it is fairly plentiful up to 5,000 feet in the moist region and is often cultivated, being known as *Et-demata*. It also occurs in the Malayan Peninsula and the Philippine Islands, but is not there regarded as an important tree.

2. Locality and Habit.

It occurs throughout deciduous forests from 300 to 3,000 feet, or even 4,000 feet occasionally, and exhibits a distinct preference for moist fertile valleys, where it grows under the most favourable circumstances straight and clean with a high rather open crown of medium-sized pointed leaves, and grey smooth bark. It loses its leaves in the hot weather and usually flowers soon after, the new leaves appearing after the flowers. Mr. H. H. Haines notes two varieties, *glaucescens* in the districts of Chota Nagpur and *canescens* in the Santal Parganas.

3. Description, Properties and Uses of Timber.

The wood is yellowish or white, even-grained, not very hard, light and strong, with a handsome lustre, the annual rings being usually marked

by a white line or pores in the spring wood. It is easily worked and takes varnish well. On a vertical section the pores show as fine wavy light brown lines. The rate of growth is fast, as few as two annual rings to an inch radius having been recorded. The Dehra Dun specimens average four rings.

Durability.—The timber lasts well as a rule in buildings, and in fresh and tidal water and does not warp or crack readily. Until it loses the bitter principle in the wood white-ants do not seem to attack it. House posts which had been in use in Bhamo, Upper Burma, were found to be in good order after 50 years. Dug-outs are said to last about 8 years. Wood placed in the sea in Madras was found to be badly attacked by the *teredo*, so that it is not always advisable to use it in tidal water.

Weight.—The average weight of the seasoned wood per cubic foot is about 36 lbs., the specimens weighed varying little, no example weighing more than 38 lbs. (Gamble). It can be floated after drying for a short time, but should not be kept long in rafts as it absorbs water and sinks.

Strength.—The value of P, which represents the strength of a bar of timber calculated from the length between supports, breadth, and thickness of the bar, and the weight in pounds placed in the middle of this which causes it to break, is about 460 (Gamble). For Sal it is 790, for Teak 600 and for Shisham 796.

Fissibility.—From tests made by Mr. R. S. Troup, the timber appears to be rather difficult to split. The tests were made with dry wood and gave an indicating figure of 6·17, Teak being easily split and giving 1·75, Deodar 1·85, *Acacia Catechu* 2·98, Padauk 3·83, Shisham 8·0, and Sal 9·33.

Calorific power.—The Forest Chemist, Mr. Puran Singh, when testing the calorific power of 56 of the commoner Indian timbers, found that *Gumhar* comes about the middle of the list. The number of British thermal Units generated by this timber is 8,075, the same as one of the Gardenias. Yew gives 7,394, *Bombax malabaricum* almost the same as *Gumhar*, and Teak, Sal, Deodar and Pines a good deal more.

Seasoning.—The timber seasons well and has long been known as a good wood to use when shrinkage is to be avoided. In the Southern Shan States the trees are girdled and left standing for some months so

that the logs will float easily, and in Orissa also girdling is sometimes carried out. It should not be used green as it shrinks to a certain extent when drying, but does not alter when seasoned.

Uses.—In Burma and Assam the wood is much used for dug-outs, and elsewhere it is in great demand for planking, furniture, panels of doors, carriages, well-work, decks of boats, toys, dolls, lacquered boxes, sandals, drums, yokes, grain-measures, plane-tables, carving, musical instruments, cattle-bells, and clogs.

In Assam it has been used for tea-boxes and it has been found suitable in match-making for sticks and inside boxes, but not for outside boxes. In the Southern Shan States it is used for bridges, and the Karens of Tennasserim use it for plates and trays. From South Tennasserim it is sent to Calcutta and Rangoon for the finer kinds of packing cases. A small consignment of timber sold in London in 1878 fetched £2 per ton. It makes fairly good unbleached wood pulp.

4. Minor Products.

The fruit, root, and bark are used in Hindu medicine and cattle and deer eat the young shoots and the fruit. The Gonds of the Satpuras protect the tree near the villages for the sake of the fruit which they eat. The leaves are sometimes used to feed the "Eri" silk worm of Assam. In Madras the juice of the root is used in dysentery and the fruit is rubbed over the scalp to cure boils, and in parts of Burma it is considered to be a mild tonic. The Karens of Tennasserim sometimes make a kind of cake of the flowers. The wood is used in India to make pearl ash (potash salts).

5. Natural Reproduction.

Seedlings are not reported to be plentiful in any of the forests, and this is doubtless due to the extent to which they are browsed down by cattle and deer. When the tree is able to get a start, as in the dense cover of old hill clearings and in thick patches of vegetation in valleys, where animals cannot reach it easily, young plants are found at times to a considerable extent. Mr. H. H. Haines considers that the species is distributed by cattle and deer which eat the fruit and reject the stones.

No difficulty is found in obtaining vigorous coppice shoots.

It is an associate of Sandal but has not been found to form root attachments with it (M. Rama Rao).

6. Artificial Reproduction.

The tree is often planted in avenues and can be readily raised from seed, the seedlings growing fast on suitable soil. In Vizagapatam about 70 per cent. of the seed put down in beds germinated. In Thana, Bombay, good results have been obtained by sowing in pits and the young plants were successfully transplanted.

7. Notes on Distribution and Extraction in different Provinces.

(*i*) *Burma.*

Vernacular names.—Yemané (Burm.), Mai' Saw (Kachin and Shan), Kama (Karen).

Local distribution.—In Upper Burma this tree is reported to be plentiful in a few divisions, but in most, as in almost all the forests of Lower Burma, it is scattered in small numbers through the moister deciduous forests up to 2,000 feet. In Bassein, Arakan, Yaw and the Northern Shan States it is said to be especially scarce. It grows with teak, *Terminalia tomentosa* and various bamboos and is often found in valleys, attaining occasionally a girth of 15 feet with a clear bole of 50 feet and a total height of 100 feet. A 30 feet bole and a 7 feet girth are, however, the largest dimensions commonly met with.

Extraction will be carried out by traders or contractors, who will obtain licenses for the number of logs required, and can then fell the trees in the unclassed forests above the minimum girth prescribed, or have them marked for felling in the Reserved forests by the Forest Department. The logs will float when green and can be dragged or carted to the nearest rafting stream. No accurate estimates can be given of the amount of timber available as no enumerations of this tree have been made, but, except in the tracts close to the large rivers, where the trees have been felled to make boats, a large supply is available and arrangements can be made for purchase and extraction with the assistance of the

Divisional officers of the divisions named in the following table :—

Division.	Government royalty.		Rate for delivery.			Local price.	
	R a.	Per	*R*	Per	At	*R a.*	Per
Myittha (Mingin) .	1 0	Log	12	Ton round .	Alon . .	...	...
			25	Do. .	Rangoon .		
Lower Chindwin (Monywa).	1 0	Do.	12	Do. .	Alon . .	5 8	Log.
Katha	1 0	Do.	6	Do. .	Nankan .	R5 to R 8	Ton.
			5	Do. .	Kadu . .		
			10	Do. .	Mandalay .		
Myitkyina . . .	1 0	Do.	19	Do. .	Do. .	6 0	Ton.
Mu (Shwebo) . .	1 0	Do.	15	Do. .	Railway stations.	30 0	Ton sawn.
						13 0	Ton round.
Pyinmana . . .	1 0	Do.	50	Ton converted.	Do.	...	...
Mandalay (Maymyo) .	1 0	Do.	35	Ton round .	Thazi . .	50 0	Ton converted.
Ruby Mines (Mogok) .	1 0	Do.	12	Do. .	Mandalay .	15 0	Ton round.
Toungoo . . .	1 8	Do.	10	Do. .	Railway stations.	...	...
Shwegyin . . .	1 8	Do.	12	Do. .	Do.	15 0	Boat.
			12	Do. .	Rangoon .		
Prome	1 8	Do.	...	...	...	10 0	Ton round.
Zigon	1 8	Do.	10	Ton converted	Railway stations.	...	...
			10	Ton round .	Rangoon .	...	...
Rangoon . . .	1 8	Do.	6	Do. .	Railway stations.	60 0	Ton converted.
Henzada . . .	1 8	Do.	20	Do. .	Do.	10 0	Log.
			50	Ton converted	...	...	...
Thaungyin } Moulmein. West Salween }	1 8	Do.	10	Ton round .	Moulmein .	45 0	Ton converted.
South Tennasserim (Tavoy).	1 8	Do.	30	Do. f. o. b. .	Tavoy .	12 0	Ton round.

NOTE.—"A ton" or "ton round" means 50 cubic feet in the round, the square of the quarter girth being imultiplied by the length, and a "log" contains usually 40 to 70 cubic feet.

(*ii*) *Eastern Bengal and Assam.*

Vernacular names.—Gomari, Gamhár, Gamri, Gambari, Gambhár, Bolkobak (Garo).

Local distribution.—The tree occurs in the moister forests of Assam from 300 feet elevation to 1,500 feet as a rule, though it is reported at 4,000 feet in the Garo Hills. It grows in Sal, bamboo and evergreen forests but is never abundant, and only in the Garo Hills is it classed even as fairly common.

Trees 12 feet in girth have been seen 70 feet in height, but the clear bole is as a rule not more than 30 feet long and the commonest maximum girth is 6 feet.

Extraction.—In Jalpaiguri the tree is worked on Coppice with Standards, but elsewhere trees are selected by the permit-holders subject to a girth limit and the control of the Forest Department. Little timber appears to have been extracted during the last five years, except in the Sylhet Division where the outturn is reported to have been 69,000 cubic feet, and no large quantities of the timber appear to be available annually. Some figures to help purchasers are given in the following table :—

Forest Division.	Local market rates.		Government royalty.		Rate for delivery.		
	₹ *a. p.*	Per	₹ *a. p.*	Per	₹ *a. p.*	Per	At
Sibsagar .	...	...	0 4 0 6 0 0	c. ft. tree	1 0 0	c. ft.	Railway stations.
Chittagong .	3 0 0	c. ft.	2 or 3 annas	c. ft.	3 2 0	„	Chittagong.
Sylhet .	0 8 0	„	0 1 0	„	1 4 0	c. ft. converted	Longai.
Cachar .	0 8 0	„	0 1 0	„	1 8 0	„	Silchar.
Jalpaiguri .	...	...	0 2 0	„	0 7 0	c. ft. round	Chalsa.
					0 13 0	c. ft. converted	„
					1 3 0	c. ft.	Calcutta.
Goalpara .	0 14 0	c. ft.	0 6 0	„	1 2 0	„	Basugaon.
					1 4 0	„	Sapatgram.
					1 12 0	„	Calcutta.

(*iii*) *United Provinces.*

Vernacular names.—Gumhar, Kamhar, Tamhar.

Only in the Eastern Circle of the United Provinces is the tree reported to occur, and it is very scarce everywhere, especially in Pilibhit. It is found in mixed deciduous forest and is extracted when found in Gorakhpur for making drums and *palkis*, but the trade is small and local.

(*iv*) *Punjab.*

Vernacular name.—Ban.

It is recorded from the lower hills of Kangra and Hoshiarpur between 2,000 and 3,000 feet above the sea, but is very rare. It is rarely if ever felled and no details are known of any local uses to which it is put.

(*v*) *Rajputana and Central India Agency.*

In the *Marwar* State it is called *Sewan* or *Sohun* and is not common, being found scattered in the Godhwar forests in moist valleys. It is used for combs and musical instruments, but there is a very small trade in it, the price it commands being about one rupee per cubic foot.

In *Ajmer-Merwara* it occurs in small numbers in the Todgarh forests where it reaches a height of 15 feet and is extracted to make musical instruments and beds.

In *Bikanir* a few trees have been grown in the State gardens.

In the State of *Rewah* the tree is not plentiful, but occasionally attains fairly large girth. It is called *Khamhar* or *Khamher* and is used for agricultural implements and furniture when available.

In *Indore* it is generally distributed but is nowhere plentiful and is seldom used, and attains good height and girth only in favourable localities near the Satpuras and Vindhyas. It is occasionally used for shoulder-poles (*Kanwar*) and for yokes. The Bhils use the wood for drums, and cattle-bells are sometimes made of it.

(*vi*) *Central Provinces.*

Vernacular names.—Siwan, Shewan, Kasmar (Berar), Khamer.

Local distribution.—In none of the forests of the Central Provinces or Berar is this tree common and in many it is very rare, never being more than one to ten acres, as in South Chanda. It goes up as high as 2,500 feet above sea-level and is usually found on light sandy trap soil in deciduous forests. In Raipur a few very good trees are found in Sal forest, but it rarely attains a girth of more than 3 feet and a height of more than 40 feet in the ordinary forests of these Provinces.

From the forests of South Chanda about 100 trees will be available annually which can be delivered at the nearest Railway station in rough squares for 12 annas per cubic foot, or at Cocanada *viâ* the Godavari River at 10 annas per cubic foot. The royalty is 5 annas per cubic foot.

(*vii*) *Western India.*

Vernacular names.—Shiwan, Shiwani, Shivana.

Local distribution.—Nowhere in Bombay is this tree at all common, never forming as much as 2 per cent. of the standing crop and usually less. It is said to be absent in Satara and very rare in the western division of Kanara and not to occur to the extent of one tree per square mile in Surat, where there are more trees in the Coppice than in the Dangs High Forest. It grows in moist forests up to 2,000 feet above sea-level, but prefers valleys with a fairly deep rich soil, where it occasionally reaches a height of 60 feet with a girth of 5 feet and a clear bole of 20 feet. In Kanara it is felled when it has reached a girth of 5 feet and in Central Thana the limit is 18 inches diameter.

Extraction.—The tree is commonly extracted in Coppice fellings though, often reserved as a standard and when sold with other species it goes with the coupe which is sold to purchasers. From the southern and eastern divisions of Kanara a small quantity of the timber may be available and can be delivered from the former at eight annas per cubic foot at Haveri or Bombay and four annas per cubic foot at Honawar on the sea-coast. From Eastern Kanara it can be delivered at Hubli on the Railway for R55 per ton of 50 cubic feet.

In *Baroda* it is very scarce and of medium size, but sells for box-making for about R3 per cart-load of 12 cubic feet.

(*viii*) *Bengal.*

Vernacular names.—Gambari, Gambhar (Hindi), Kamare (Nepalese), Kusmar (Kol), Kasamar (Ho and Munda).

Local distribution.—In the lower hill forests of the Tista it is reported to be fairly abundant, but is scarce in the adjoining mixed plains forests and elsewhere in Bengal and Orissa, being very often classed as rare. It ascends to 3,000 feet favouring shady ravines and attains a height of 100 feet occasionally in such places in the Tista forests where the exploitable size is 7 feet. In village lands in Singhbhum trees of 9 feet in girth may be seen. Its greatest height is 100 feet with 60 feet of clear bole. In Orissa the exploitable size is five or six feet, and trees above that are usually unsound.

Extraction.—When the timber is required trees are selected, usually in conjunction with improvement fellings for sal, according to the demand. Details of past extraction are of little value as very little has been felled and only from the Tista forests can a regular annual outturn be expected. It might amount to 60 trees, the local value of the timber being 10 annas to ₹1 per cubic foot or ₹4 per 100 running feet of $\frac{1}{2}$ inch planks. The timber can be delivered at Bagracote Railway station on the Bengal Dooars Railway for 12 annas per cubic foot and at Siliguri for 13 annas. Elsewhere in Bengal the wood sells for 8 annas to ₹1-4 per cubic foot and the royalty is one or two annas per cubic foot.

(*ix*) *Southern India.*

Vernacular names.—Summadi (Telegu), Kumisha or Pokki (Malyalam), Kumili or Gumudu (Canarese), Kumbalam, Kumalamaram, Kumulu, Kolla kattathekku (Tamil), Gombari (Uriya). Also called Gum Teak.

Local distribution.—In Guntur and Nellore the tree is reported to be absent, and it is nowhere plentiful in the Madras Presidency. In a few of the forests in South Coimbatore and North Malabar it is found up to a maximum of 4 per cent. of the growing stock, but this is exceptional, and neither in numbers nor size does it assume an important position in Madras. From Madura trees 6 feet in girth and 30 feet in height have

been reported, but most of the trees found are much smaller, of poor height growth with little clear bole. A few large trees have been seen in Vizagapatam. In this district it is usually found in the plains outside the forests, but as a rule it grows in deciduous forests between 800 and 3,000 feet, ascending to 4,000 feet in Madura on the Palni Hills. It is fairly common in the moister portions of the hills of North Coimbatore, and was common in 1870 in Ganjam and Vizagapatam (Col. Heber Drury).

Extraction.—The tree is little in demand and is felled only in the fuel coupes nor can estimates be given of the future annual amount available which will never be worth the consideration of timber traders.

In *Coorg* the tree is known as *Kuli* in Canarese and is found throughout the deciduous forests attaining a girth of 4 feet. It is not often felled but is used sometimes by the villagers for rice-pounders and water-troughs. The Government royalty is 1½ annas per cubic foot.

In *Hyderabad* it is called *Shewan, Gumartek,* or *Gumari,* and is generally distributed but not common.

It is much used for yokes, also for furniture, planking, carts, drums and cattle-bells. It rarely attains a girth of 4 feet, and is one of the timbers granted free to agriculturists.

In *Travancore* the tree is widely distributed but not abundant between sea-level and 2,000 feet. It is rarely found larger than 1 foot in diameter and is not often used. The native names are *Muithekki* and *Kumbil* (Bourdillon).

In *Mysore* it is very sparsely distributed in all the deciduous forests, attaining in favourable localities 30 feet in height and 6 feet in girth. About 5,000 cubic feet may be obtained annually, delivered at Railway stations at R1 per cubic foot. It is called *Kuli.*

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NOTE ON BIJA SAL OR VENGAI

(*Pterocarpus Marsupium*, Roxb.)

BY

A. RODGER, I.F.S.

CALCUTTA
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5453

BIJA SAL OR VENGAI.

Pterocarpus Marsupium, Roxb.

Natural Order—Leguminosæ (Papilionaceæ).

1. General Distribution.

The eastern limit of this tree is 88° longitude, and the western 72°, but it hardly occurs to the north-west of a line joining Baroda and Shahjehanpur, and is principally a tree of the Peninsula. In Ceylon the tree is stated by Prain to occur in the central parts of the island. It does not occur in Assam, Burma, and the Punjab, and was formerly much commoner in Central and Southern India than it is now. Further details are given under the various provinces.

In Ceylon it is fairly common in dry and intermediate regions up to 3,000 feet, and rarer in the moist region on open grass land, and is called *Gammalu*.

2. Locality and Habit.

The tree is found in deciduous forests at all heights between sea-level and 3,000 feet, but is commonest between 500 and 1,500 feet and is rare at the lower levels. It prefers north and west aspects on hilly ground and grows best on a sandy or slightly clayey loam, with bamboo, Albizzias, Terminalias, Anogeissus, and Sal, reaching a height of 100 feet and a girth of 8 feet in the best localities of Chanda, and as much as 16 feet occasionally in Southern India. It is a tall tree, often not very straight, with a rather open leafy crown, the leaves being compound with five to seven alternate leaflets which are 3 to 5 inches long. The yellow or white flowers appear towards the end of the rains, and the new leaves at the end of the hot weather, but the tree is leafless for a very short time only. Several varieties have been distinguished by Prain, described in his report written in 1900 (Inspector-General of Forests' Proceedings for September 1900). Foulkes in "Notes on Timber Trees of South Kanara" says: "Grows in laterite when there is plenty of

moisture in the soil and will grow well on rocky laterite. Well suited to gneissic soils, but will not grow on the sandy soils of the coast."

3. Description, Properties and Uses of Timber.

The sapwood is narrow, soft, and white, the heartwood handsome, hard, yellowish or reddish-brown showing yellowish smooth vertical streaks on a vertical section. It is often cross-grained but takes a fine polish and seasons well. The yellow stain contained in the wood comes off when it is wet.

Durability.—It is a durable timber but should be kept dry, and is not liable to split. It has been tried for sleepers on the Mysore State Railway, twenty out of twenty-five being found to be serviceable after seven years' use, and lasts a long time as door and window frames. The Great Indian Peninsula Railway Company laid down 322 sleepers in 1879-80 and reported in 1883 that those which had been cut out of heartwood lasted very well and held the spikes firmly. Edward Balfour in "The Timber Trees, Timber and Fancy Woods," as also, "The Forests of India and of Eastern and Southern Asia," 1862, says that it was much used for buildings on the Bombay side, but should not be exposed to wet, and was not attacked by white-ants for at least twenty years. It was tried for sleepers on the Rajpipla State Railway in Bombay in 1897 and lasted for three years only. Wood placed in the sea in Madras was found to be badly attacked by the *teredo*.

Weight.—The average weight of the wood per cubic foot is about 55 lbs., the highest recorded being 63 lbs. and the lowest 47 lbs. (Gamble).

Strength.—The value of P, which represents the strength of a bar of timber calculated from the length between supports, breadth and thickness of the bar, and the weight in pounds which, when placed on the middle of the bar, causes it to break, is 718, the figure for Sal being 790, Teak 600, and Shisham 796 (Gamble).

Fissibility.—The wood is difficult to split as it is cross-grained, coming almost at the bottom of a list of 61 Indian woods tested by Mr. R. S. Troup. Teak, one of the easiest to split, is represented by the figure 1·75 in this list, Sain by 4·63, Sal by 9·33, and the timber under report by 11·33.

Calorific power.—It is used for fuel, but is not one of the best woods for the purpose, the number of British Thermal Units being about 7,324.

Only a few of the Indian woods tested by Mr. Puran Singh come below this, and Sal, Teak, and Blue and Chir pines give much higher values.

Seasoning.—In Orissa the logs are usually seasoned in tanks, and in the Central Provinces this method is also used at times or the logs are left unbarked in the forests. In Bombay the trees are sometimes girdled three years before felling. Both methods probably have their advantages depending on whether the gum resin, which stains yellow when damp and apparently repels white-ants, is to be removed or not. For ordinary purposes the timber can be well and thoroughly seasoned by stacking it in shady, airy places.

Uses.—This timber is, after teak and blackwood, the most valuable tree of Southern India, and especially of Mysore. It is much used for door and window frames, posts and beams, furniture, agricultural implements, boat and cart building, and especially spokes and felloes. When used for furniture it is heavily varnished to prevent the exudation of the strong yellow dye which may take place when wet after years of seasoning. In the Central Provinces it is also used for drums, idols, grain-measures, pit-props in the Mohpani coal-mines, and spokes and felloes of gun-carriages in the Gun Carriage Factory at Jubbulpore. In certain parts of Madras its use for building is confined to Government buildings and temples, and in Coimbatore it is not placed where it can come into contact with the feet, in deference to local superstition. In Bombay it has been used for railway carriage building, and it has been several times tried in various places for sleepers as noted above, but is not common enough to be considered as an available future source of supply. About the year 1883, 80,000 sleepers were put down in the line between Katni and Bilaspur in the Central Provinces. In 1900 a number of sleepers were supplied from Warangal to the Hyderabad-Godavery Valley Railway and lasted for seven or eight years though cut from unseasoned wood. In Balfour's work quoted above it is noted fifty years ago that the timber was apt to be unsound and to contain numerous faults of a coal black and charred appearance, thereby being often unsatisfactory for joists, but when these were not present it was a most valuable timber. Vessels built at that period in Ganjam were planked with it. It was evidently much more plentiful then than at the present day, especially on the Nilgiris and the Malabar and Kanara Ghats, large trees being common and the wood much used. Its price at Nagpur was at that date 5 annas per cubic foot.

4. Minor Products.

When the bark is blazed a red gum exudes which hardens quickly in brittle, black, shining angular pieces and is exported to Europe as "Kino" where it is used in medicine as an astringent, containing as much as 75 per cent. of tannic acid. The best season for collection is in the dry weather when the tree is in flower. It does not, however, appear to be collected to any great extent at the present time. Some notes supplied from North Malabar in the "Indian Forester" for July 1899 describe the method of collection. A number of short slanting cuts, about 1 inch wide, draining into a central vertical cut, are made in the bark, and the gum, which flows from them in about twelve hours, is caught in a bamboo tube. Only trees 6 feet in girth and above may be tapped, and they may only be tapped on one side unless they are over 8 feet in girth. The gum was dried in a wooden shed in shallow tin trays, about a fortnight being required in the dry weather. Artificial heat or exposure to the sun was found to spoil the quality. A tree 6 feet in girth was said to yield about 3 lbs. of liquid gum or 1 lb. of dry gum, and it was estimated that the trees might be tapped on alternate sides once in five years. This product is fully discussed in "Agricultural Ledger" No. 11 of 1901. In this it is noted that "*the genuine Malabar kino is an important indigenous drug in India which has been recognized many years in the British and other Pharmacopœias. An unlimited supply is now obtainable through the Forest Department at a price that will preclude all competition of other articles of a similar nature.*" Its history is traced from the year 1757, its first appearance in Europe having apparently been in the Edinburgh Pharmacopœia as *Gummi Kino*. The name Kino is probably derived from an African word *Kano*, the name of *Pterocarpus erinaceus*. In the middle of the last century the gum was extracted much more extensively, and Balfour, in the work above quoted, notes that "Dr. Cleghorn saw two thousand trees along the roads through the Wynaad, notched in a V-shaped form for the extraction of Kino which meets with a ready market on the coast, and is exported in wooden boxes to Bombay." According to the Ledger above quoted, in North Malabar alone about 2,000 lbs. can be produced annually at a cost price of not more than 4 annas per pound, but there is little demand in India except from the Government Medical Store Departments.

It is reported that the quantity available for extraction in the Quilon

Division, Travancore, is between 3,000 and 5,000 lbs. per annum, but it is not collected nor exported at present from Travancore.

In October 1874 the price of Kino in London was about 8*d.* per pound, but it rose in 1894 to 4*s.* 6*d.* and shortly afterwards to 17*s.*, where it remained for some time. In 1896, as a result of measures taken in India through the Forest Department, the price fell to 12*s.* and at the end of the year 1899 to 2*s.* In 1900 the low price of 1*s.* per pound was reached. Since then it appears to have remained at much the same level and is now quoted in London at 9*d.* to 1*s.* 2*d.*

It is said to be used in Europe to a considerable extent in the manufacture of certain wines, but from the latest figures obtainable from the Collector of Customs in Madras and Bombay and from the Conservator of Forests at Coimbatore, it appears that the demand has recently fallen off and that collection has almost ceased. The Conservator of Forests states that the gum used to be collected in North Malabar in considerable quantities, but ceased owing to the fall in prices, and the small remainder of the stock in hand was sold in June 1908. The Collector of Customs, Bombay, reports that there were no exports of the gum from that port between 1905 and 1910. The Collector of Customs, Madras, supplies the following figures which show the export of Gum Kino from the Madras Presidency :—

Countries to which exported.	1907-08.		1908-09.		1909-10.		1910-11.
	Cwt.	₹	Cwt.	₹	Cwt.	₹	
United Kingdom . .	37½	2,706	22½	945	24½	1,402	*Nil.*
United States of America .	...	...	7½	315	7½	630	*Nil.*
Total .	37½	2,706	30	1,260	32	2,032	*Nil.*

In 1900 proposals were made that tannin should be extracted on a large scale from the bark for tanning purposes. An extract of a sticky consistency prepared in Coorg from the bark after immersion in water was found to contain 38 per cent. of tannin, and the dry extract made from

this contained 91 per cent., so that the product will probably command a ready sale when it can be prepared cheaply on a large scale.

In 1907 experiments were made in Western Australia with the Kino as a means of preventing sacks from being destroyed by acid superphosphate which was shipped as a fertiliser, and gave most favourable results, the sack which had been treated with a strong solution of the gum being intact after being stored for six months full of the fertiliser. The leaves form excellent fodder for cattle and are also in demand for manure, and the tree gives good shade for coffee. The bark contains a brownish-red colouring matter which produces reddish-fawn colour with *tasar* silk. It has been noted by Mr. Rama Rao to be an associate of Sandal, but root attachments between the two have not been found.

5. Natural Reproduction and Rate of Growth.

According to Gamble the seed crop is not annual but intermittent and the seeds do not always germinate well. The pods fall in the dry season and are likely to be burnt, a danger to which Burma Padauk is also liable. Fire and grazing are great hindrances to the formation of a good crop of seedlings, to which a good start would be afforded by digging the surface soil so as to enable the seeds to obtain a lodgment, as if left on the hard surface among grass they have little chance of development. Moderately good regeneration is reported from most parts of India where the tree occurs, but seedlings as well as seeds evidently suffer much from fire, being slow-growing and requiring several years to become strong enough to resist it. As with teak seedlings, small plants when examined will frequently be found to have thick gnarled stems at ground level, representing several years' growth. The tree coppices readily.

In 1895 Mr. H. C. Hill noted in the Central Provinces that this and other species formed dense thickets wherever the beneficial influence of an old Mohwa tree was felt.

Mr. A. W. Lushington notes that in the hill forests of North Coimbatore, "Vengai" seemed to stand fire better than teak, and in places where the forests had been absolutely ruined by fire there still existed in 1902 a few dilapidated-looking trees. Excellent reproduction was to be found here and there.

Mr. R. S. Pearson records the following figures showing the rate of growth of "Honni" in the Kalinaddi slopes and Ankola High Forest in Kanara, Bombay :—

Age.	Average diameter in inches.	
	Kalinaddi.	Ankola.
10 years	1·9	1·65
20 „	3·5	3·41
30 „	5·4	5·41
40 „	7·3	7·44
50 „	9·1	9·27
60 „	10·7	11·24
70 „	12·4	12·35
80 „	13·8	13·88
90 „	15·4	15·56
100 „	16·9	17·20
110 „	18·5	18·57
120 „	19·9	19·54
130 „	21·2	19·73
140 „	22·2	22·12
150 „	23·3	24·32
160 „	24·0	26·30
170 „	25·3	27·20

From countings made in the Nallamalai forests, Kurnool, Madras, the average number of rings to each inch of diameter was found to be five. In the Walayar Reserve, Coimbatore, Madras, ten trees were measured annually at 4 feet from the ground, and gave the following results :—

Girth in inches.			
1892.	1899.	1892.	1899.
34½	44½	33	43
33½	44	33½	43½
33½	47	34	44½
37½	48	31½	41½
19	29	32½	42½

In the same forest coppice growth attained a girth of 1½ inches in one year.

In the Begur Forests Working-Plan, North Malabar, Madras, 13 trees gave the following results :—

Average age at	6	inches	diameter . .	35·6 years.
„	12	„	. .	68·8 „
„	18	„	. .	106·1 „
„	24	„	. .	144·5 „

In the Chedleth Range forests in the same district 100 trees gave the following results :—

Average age at	6	inches	diameter . .	32·7 years.
„	12	„	. .	62·5 „
„	18	„	. .	92·4 „
„	24	„	. .	124·2 „

F. Foulkes says in "Notes on Timber Trees in South Kanara":— "Yields only a moderate seed crop and apparently does not yield an annually equal crop. Does not germinate well. Reproduction is moderate therefore: one reason being that the seeds, being very light, are easily blown away by the monsoon winds and washed away by the monsoon rains before they have time to anchor themselves, and the fruit falling in the fire season, and the membranous wing becoming dry and inflammable, renders the seed very liable to damage by fire. Seeds retain their vitality for a long time."

6. Artificial Reproduction.

Sowings have been made in several parts of Bombay and Madras with fairly successful results. The hard bony covering of the seed often prevents germination during the first rains, and it may be hastened by cutting it sufficiently to expose the seed. The seedlings are only about 6 inches high after the first year's growth and must be protected from fire for a number of years depending on the soil covering. A tree planted in Chaibassa was 20 feet high and 10 inches in girth after ten years. Sowings in the forest are much damaged by deer, and sowing in pits is usually more successful than broadcast sowing. From Vizagapatam a note is sent of the seeds having been steeped in camphor water, after removing the husk, for 12 hours and then sown in a flower pot, germination on the fifth day being the general result. In Central Coimbatore a plantation was made some thirty years ago, and now contains about 200 trees in excellent condition up to nearly 7 feet in girth.

In the same division a small mixed plantation was made three years ago on a dry stony soil. The seedlings were put out in split bamboo baskets in pits $1\frac{1}{2}' \times 1\frac{1}{2}' \times 1'$ and 50 per cent. of them are thriving. In Tinnevelly rows 3 feet wide are cleared in felled coupes and one or two seeds put in patches 3 feet apart and $\frac{1}{2}$ inch deep. They have germinated readily but suffer from deer and do best when shaded from the morning sun.

7. Notes on Distribution and Extraction in different Provinces.

(*i*) *Central Provinces.*

Vernacular names.—Bija Sal, Bija, Dhorbiola, Bewla, Bijra.

Local distribution.—In Berar the tree is very rare and is seldom extracted, and elsewhere in the Central Provinces its distribution is irregular. In Balaghat it is said to form about 10 per cent. of the growing stock, in Chanda, Saugor, and Damoh it is fairly common, and in most of the other forest districts it is found here and there. It grows in deciduous forests with teak, khair, and bamboo, usually on hilly ground between 500 and 2,000 feet, preferring north and west aspects, and a sandy or slightly clayey loam. In Chanda trees measuring 8 feet in girth and 100 feet in height are found at times, but 3 to 4 feet in girth, 20 feet clear bole, and 40 feet total height are the commoner measurements elsewhere.

Extraction.—Most of the forests containing the tree are worked as Coppice with Standards, a few, as in Chanda where the best trees occur, under the Selection system as a rule, mature trees being removed when required. Purchasers remove the timber from the coupes they have acquired by dragging and carting in most cases, but from South Chanda floating is possible on the Godavery, one log being buoyed by one teak log. Little accurate information is available regarding the amount of timber available annually, but estimates are given below as a guide to purchasers of the timber from the various forests of the Central Provinces where it is now available, or will become available when the forests are opened out.

Figures regarding Extraction.

Division.	Government royalty.		Local market rate.		Rate for delivery.		
	R a. p.	Per	R a. p.	Per	R a. p.	Per	At
Chindwara	0 10 0	Cubic foot	1 0 0	Cubic foot	0 4 0	Cubic foot squared.	Chindwara.
					1 3 0	Do.	Nagpur.
Saugor	...	...	2 0 0	Cart-load	0 3 0	Cubic foot	Kareli.
					0 4 0	Do.	Saugor.
							Ganeshganj.
					1 0 0	Do.	Bombay.
					0 8 0	Do.	Jubbulpore.
					0 8 0	Cubic foot round.	Ry. stations.
Mandla	0 3 4	Cubic foot	0 8 0	Cubic foot	0 12 0	Cubic foot converted.	Ditto.
					0 2 0	Cubic foot	Ditto.
Damoh	...	...	...	...	0 13 0	Do.	Bombay.
					0 5 0	Do.	Jubbulpore.
					0 11 0	Do.	Dhamtari.
Raipur	0 3 0	Cubic foot	1 0 0	Cubic foot	0 13 0	Do.	Raipur.
South Chanda	0 5 0	Do.	...	...	0 9 0	Cubic foot squared.	Ballarshah.
					0 10 0	Do.	Rajahmandri near Cocanada.

In the Working-Plan for Working Circle No. 1, Allapilli forests, Chanda, Central Provinces, in area 31 square miles, the following figures are given :—

Number of sound trees above 24 inches diameter . . .	406
„ „ „ 18—24 „ „ . . .	1,741

The minimum limit for felling is at present fixed at 24 inches diameter.

(*ii*) *Rajputana and Central India Agency.*

In the *Marwar State* it is found scattered at 3,000 feet on the upper slopes of the Southern Aravali hills, but it is not plentiful or large as

it is much cut over by the villagers who use it for ploughs, flag-staffs, etc.

In *Gwalior* a few small trees occur, but it is of little importance. It is called *Bija*.

In the *Rewah* State the tree forms about 5 per cent. of the crop in 3 tehsils and grows to 4 feet in girth. It is largely used and not more than 4,000 cubic feet will be available annually in future, the royalty to be paid being 4 annas per cubic foot. The market rate near the railway line is 12 annas per cubic foot.

In *Indore* it is called *Bea* or *Bija* and was formerly fairly abundant, but owing to heavy exploitation few big trees are now to be seen except in inaccessible valleys near the Satpuras where trees of 6 feet in girth occur. It is well-distributed but abundant only near the Nerbudda in the Burwaha Range, in the south-west of Nimawar District and in parts of the Satpuras, and does not often attain a girth of more than 4 feet.

The timber is valued for building and poles of 2 feet girth are dressed and sold as shafts, the value of the timber being about R1 per cubic foot and of shafts 10 annas each.

(*iii*) *Southern India.*

Vernacular names.—Yegisey, Yegi, Vengai (Tamil), Benga, Netra honne, or Honne (Canarese), Piasal (Uriya).

Local distribution.—This tree is one of the most important in Madras and Mysore and occurs scattered over the deciduous forests in most districts, but very seldom grows gregariously. In the Wynaad forests of the Nilgiris the most favourable localities have as much as 10 per cent. of the total crop consisting of this tree, and this percentage is reached in a few other forest tracts, but elsewhere it is much scarcer and is of no importance in Guntur, Bellary, Chingleput, and districts where the forests generally are poor. It grows with Sal in the north, and with Albizzias, Anogeissus, and Terminalias in deciduous forests at all heights above sea-level up to 3,000 feet, but is commonest between 500 and 1,500 feet and is rare on the lowest levels. In the forests of the northern part of the Presidency it very rarely attains large size, but increases in Coimbatore, Madura, and Tinnevelly. Seven feet in girth is a good tree there, but in Coimbatore it grows occasionally to 16 feet girth and 100 feet in height, with a clear bole of 40 feet.

Extraction.—The forests are worked under Coppice with Standards and Selection systems, and the districts from which constant supplies of good timber can be expected are very few. In Madura the girth limit for felling is 7 feet, about 150 trees having been extracted during the last five years, selling for R40 each on the average. In South Kanara the exploitable size is 2 feet diameter. The information available regarding the quantities available is very vague and purchasers are advised to make enquiries direct from the forest officers in charge of the divisions mentioned in the table given below. The Malabar Timber Yards and Saw Mills quote R2 per cubic foot for scantlings and R2-2 for planks free on rail at Kallai. They call it *Wynaad Padauk.*

In *Coorg* the tree is called *Honné* in Canarese and is found throughout the deciduous forests, attaining in the south a girth of 10 feet. It is locally in great demand for house-building and agricultural implements, 150,000 cubic feet having been felled during the last five years. About 30,000 cubic feet may be obtained annually. The Government royalty is 8 annas per cubic foot. The market rate in 1892 was 10 annas as at present.

In *Hyderabad* it is known under several names, *Bija Sal, Bija, Pedda Yegi, Nettrani, Nettar, Hoanni, Ruggedbairu, Dorebubla,* and is regarded as the most valuable timber of the State, large teak being now very scarce. It is in great demand for buildings and carts, but large trees have been destroyed in many parts for cattle fodder, and this waste is still going on, so that its disappearance, except in reserves, may be anticipated. Near the Godavery in the Mahadeopur, Pakhal, and Poloncha forests a fair number of good trees are still to be found, 6 to 8 feet in girth, but little extraction is now allowed as the forests have been overworked in the past. The royalty is R1 per cubic foot and the market price at Warangal R1-12.

In *Mysore* it is called *Honné* and is much used for building and carts, being common in the Mysore and Shimoga forests. About 40,000 cubic feet may be extracted annually. Ninety-four thousand cubic feet have been extracted during the last three years.

In *Travancore* the tree is common in deciduous forests up to 3,500 feet and stands sixth on the list of useful woods of the State. It is thought locally to be too heavy for furniture and the yellow stain from the wood prevents it being very largely used, *Terminalia tomentosa, Hopea parviflora,* and *Artocarpus hirsuta* being preferred, but it sells

largely for export. About 36,000 cubic feet are sold annually, its value on the coast being 12 to 14 annas per cubic foot in the log (Bourdillon).

Figures regarding Extraction.

Division or State.	Local selling rate.		Rate for delivery.		
	₹ a.	Per	₹ a.	Per	At
Lower Godavery.	1 4 to 1 10	Cubic foot round.	...	...	...
Central Coimbatore.	1 6	Do.	0 4 to 0 8	Cubic foot.	Railway stations.
South Coimbatore.	...	...	1 8	Do.	Podanur.
Madura . .	2 0	Cubic foot squared.	2 14	Cubic foot squared.	Amonayanaickanoor.
			2 0	Do.	Cumbum.
			3 0	Do.	Madura.
Tinnevelly .	1 12	Cubic foot scantlings.	1 12	Cubic foot in scantlings. Travancore wood.	Shenkottah.
North Malabar	0 8	Cubic foot squared.	1 2	Cubic foot	Calicut, Tellicherry, Mysore, Nangangode.
Coorg . .	0 10	Cubic foot .	0 15	Do.	Paschamavahini Station, Mysore.
Mysore . .	1 0 to 1 6	Do. .	1 4	Do.	Railway stations.

Figures from Madras Working-Plans.

District.	Working Circle.	Area in square miles.	Number of trees Diameter in inches.							Remarks.
			1″—6″	6″—12″	12″—18″	18″—24″	24″—30″	30″—36″	Over 36″	
Coimbatore	Punachi Anamalai Hills.	4	21,000	5,000	2,300	00	600	2:0	260	Annual yield 3,915 cubic feet.
South Coimbatore.	Thalingi .	8	4,500	1,900	620	170	19	9	19	

From the Coorg Working-Plans the figures given below have been taken. As, however, the Working-Plans have mostly expired, the figures must be taken merely as a guide to the amount of timber that may at present be available annually, and up-to-date figures should be obtained from the Deputy Conservator of Forests, Coorg.

Name of forest.	Area in square miles.	Quantity in cubic feet available annually.
Devamachi-Mawkal	28	2,400
Nalkeri-Hatgat	83	20,400
Anekadu-Attoor	20	8,340
Arkeri	29	2,000

(*iv*) *Western India.*

Vernacular names.—Bibla (Marathi), Honne, Asana, Bio (Gujarati).

Local distribution.—Five per cent. is the highest proportion of the growing stock that the species ever occupies in Bombay, and three trees per 5 acres are reported from the eastern part of Kanara, a district where it appears to be generally plentiful. In Surat as many as ten trees to the acre are occasionally found, but in Poona and Khandesh it is very scarce, and is not found in Satara, being thus a tree principally of the southern part of the Presidency. It grows best at an elevation of 1,000 feet or so and can grow in exposed situations, but occurs in most of the deciduous forests between 500 and 2,500 feet, and prefers quartzite to black soils. It attains a girth of more than 8 feet in Western Kanara and a height of 90 feet with a clear bole of 50 feet, but smaller sizes are much more common.

Extraction.—In the forests where the tree yields timber, trees are selected for felling. In Central Thana 18 inches is the minimum diameter taken, in the Eastern Divisions of Kanara 75 inches in girth, and in the Western Division 6 feet. In Kanara a good deal of extraction is done by Government agency, but coupes are sometimes sold to purchasers here as is commonly done elsewhere, most of the timber being carted from the

forests, but dragging from the stump being sometimes necessary, and boats are employed in the south. From a few divisions timber may be obtained, but reliable estimates of the amount available annually have not yet been made in most of them. Some figures regarding extraction are given below. The royalty is R6 per khandy of 12½ cubic feet in Kanara.

In the *Rajpipla* State the tree occurs in most of the hill forests, being occasionally as plentiful as 25 trees to the acre, and attaining a girth of 36 inches. During the years 1904 to 1909, 20,000 cubic feet were extracted and the quantity available annually in future is estimated at 5,000 cubic feet, the duty levied by the State being 3 annas per cubic foot. Converted timber can be delivered at about three times the rates quoted for rough timber in the table below. The logs are extracted by Bhils and when possible are floated down the Nerbudda, most of them finding their way to Baroda, Ahmedabad, or North Gujrat.

In *Baroda* it is scarce, but sells for R3 per cart-load of 12 cubic feet when available.

Division or State.	Market rate.		Rate for delivery.		
	R a.	Per	R a.	Per	At
Eastern Division, Kanara.	12 0 to 15 0	Khandy of 12½ cubic feet.	1 2	Cubic foot	Hubli.
Southern Division, Kanara.	15 0	Do.	0 4	Do.	Honawar.
			0 8	Do.	Haveri, Bombay, Mangalore, Calicut.
Western Division, Kanara.	12 0	Do.	0 6	Do.	Sea-coast.
Surat . .	12 0 to 20 0	Do.	0 14	Do.	Tapty Valley Railway.
			1 0	Do.	Bulsar.
			1 1	Do.	Surat.
Rajpipla State .	0 12	Cubic foot round.	0 12	Do.	Nandod or Chandod.
			0 14	Do.	Ankleshwar.

Figures from Bombay Working-Plans.

District.	Working Circle.	Area in square miles.	Mature trees on the area.	Minimum size fixed for felling.	Remarks.
Kanara .	Gund, Series XI.	25	830 above 24″ diameter.	24 inches diameter.	
Do. .	Supa, Block XX.	18	64 above 24″ diameter.	6 feet girth.	
Do. .	Kalinaddi slopes.	42	1,200 sound trees above 24″ diameter : 120 unsound.	6 feet girth.	Annual yield 40 trees.
Do. .	Mundgod High Forest.	85	1,400 above 24″ diameter.	6 feet girth.	
Do. .	Ankola High Forest.	70	1,500 above 24″ diameter.	6 feet girth.	
Do. .	Yellapur above Ghat.	137	2,800 above 24″ diameter.	24 inches diameter.	
Do. .	Yellapur slopes, Block XVII.	16	350 above 24″ diameter.	...	
Belgaum .	Nagargali Series	14	30 above 24″ diameter.	...	

(*v*) *Bengal.*

Vernacular names.—Bija, Bija Sal, Paisar (Hind.), Hid (Kol), Murga (Santali), Bia (Kharw.).

Local distribution.—The tree is not common in Bengal, rarely of large size in the Santal Parganas and Palamau, and absent in the Kurseong, Darjeeling, and Tista forests. It is found elsewhere in deciduous plains forests with Sal and in the dry mixed hills forests up to 3,000 feet above the sea. In Orissa, Sambalpur, and Singhbhum good trees 7 feet in girth may be found, with an occasional specimen 10 feet in girth, the height reaching 100 feet and the length of clear bole 50 feet. It is the best tree for planking in Chota Nagpur and deserves to be largely planted as the supply is very limited (H. H. Haines).

Extraction.—Trees are selected for felling according to the demand and sylvicultural requirements of the forest, but no large supply can be expected from the forests in Bengal and little, if any, will be available for export. From Sambalpur about 2,000 cubic feet may be available annually, from Puri 300 cubic feet, and similar quantities from Chaibassa, Angul, and Singhbhum. The royalty is usually 4 annas per cubic foot dry and 6 annas per cubic foot green, and the local price varies from 12 annas to ₹1-8 per cubic foot. At Lota Pehar Station the timber can be delivered from Chaibassa at 8 to 12 annas per cubic foot. From Sambalpur to railway stations the rate is ₹1 per cubic foot round and ₹1-4 per cubic foot sawn and to Calcutta ₹2 per cubic foot in the log.

In the Raigoda Range of the Angul Division 891 trees over 2 feet in diameter were counted on an area of 30·2 square miles, in 1907, and in the Bagmunda Range, 38 square miles, the number was 901. These trees are to be felled with the mature Sal in the annual coupes.

(*vi*) *United Provinces.*

Vernacular name.—Bija Sal.

Local distribution.—The tree is rare in the United Provinces, only the Bundelkhand, Gorakhpur, and Pilibhit Forest Divisions reporting its presence in appreciable quantities. In Gonda three trees have been seen and in Kheri a few trees occur here and there in the alluvial areas. It does not come so far north as the Siwaliks. The largest girth it reaches is 5 feet and a small number of logs up to 20 feet long and 4 feet in girth might be obtained, the market price in Gorakhpur being about 8 annas per cubic foot.

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NOTE ON SAIN OR SAJ

(*Terminalia tomentosa*, W. & A.)

BY

A. RODGER, I.F.S.

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NOTE.

THESE notes regarding the lesser known Indian timbers have been compiled in order that all the information at present available regarding them may be easily obtainable.

For some of the best forests detailed Working-Plans have not yet been made, as the demand for timber in the neighbourhood is at present very small, but full information regarding the timbers available and means of extraction can always be obtained from local forest officers.

Application can also be made at any time to the Forest Economist, Dehra Dun, United Provinces, India, who will supply specimens of any timber free and put enquirers in communication with local forest officers.

Notes on the following timbers have now appeared :—

1. Lagerstrœmia tomentosa (*Leza*—Burma).
2. Dipterocarpus tuberculatus (*In*—Burma).
3. Pterocarpus dalbergioides (*Padauk*—Andaman Islands).
4. Pterocarpus macrocarpus (*Padauk*—Burma).
5. Carallia integerrima (*Maniawga*—Burma).
6. Diospyros Kurzii (*Zebra Wood*—Andaman Islands).
7. Berrya Ammonilla (*Petwun*—Southern India and Burma).
8. Terminalia tomentosa (*Saj, Sain, Taukkyan*—India and Burma).
9. Gmelina arborea (*Gumhar, Siwan*—India and Burma).
10. Ougeinia dalbergioides (*Sandan, Tiwas*—India).
11. Lagerstrœmia lanceolata (*Benteak, Nana*—Southern India).
12. Anogeissus latifolia (*Bakli, Dhaura*—India).
13. Pterocarpus Marsupium (*Honné, Vengai*—India).

Reference is also invited to the following :—

A Manual of Indian Timbers, by J. S. Gamble, C.I.E.
(Sampson Low, Marston & Co., London.)

Indian Woods and Their Uses, by R. S. Troup.
(Superintendent, Government Printing, India, Calcutta.)

Sain or Saj.

Terminalia tomentosa, W. and A.

Natural Order—Combretaceae.

SAIN OR SAJ.

Terminalia tomentosa, W. and A.

Natural Order—Combretaceæ.

1. General Distribution.

This tree is one of the commonest and most widely distributed in India, being found in abundance in the United Provinces, Bombay, Madras, Bengal, and Burma. In Eastern Bengal and Assam, South Tennasserim, Arakan, Southern Madras and North-Western India it is scarce or absent, apparently not occurring in Upper India west of 76° longitude and north of 24° latitudeand ceasing in both Peninsulas about 10° latitude. Further details are given under each province.

It is recorded from Ceylon in the Flora of British India but it was probably planted.

2. Locality and Habit.

The range of this species is very wide as it is found almost from the sea-level in the Peninsulas up to 4,000 feet on the lower slopes of the Himalayas and the hills of Upper Burma. It grows best, however, between 300 and 2,000 feet, becoming stunted on the higher levels. It prefers deep fresh loams containing more clay than sand, and is often found on low-lying moist localities, and in *nalas*, as it is able to stand a good deal of water-logging. It is one of the few species which grow abundantly on black cotton soil in the Central Provinces though it remains stunted in such localities. On laterite it is found in great abundance in certain districts but is often small and crooked.

F. Foulkes in "Notes on Timber Trees—South Kanara" says :—

"Will grow in almost any soil but prefers a deep moist clayey soil of alluvial origin : the blacker the bark, the better the factors of the locality suit the tree. When it is hollow the bark becomes an ashy grey over the spot.

It grows very fairly in dry shallow rocky laterite plains but becomes stunted on the bare dry upland laterite hills. Prefers a laterite to a gneiss soil. It is entirely absent on sandy soil. Is especially useful for regeneration of lands in which the soil has deteriorated by exposure owing to reckless grazing and fires.

It seems to stand a dry climate as well as a moist one and to require less rainfall than most other trees, but the more rain it has the more luxuriant its growth."

It is a tall straight tree with spreading branches and heavy crown, and may usually be recognised by the very thick rough dark-coloured bark which is deeply cracked longitudinally. It loses its leaves annually during the hot weather and produces a new flush after most of the surrounding species, sometimes not until the end of June, the flowers appearing during the rains. On the higher and barer slopes the leaves are rather large and are covered with down, but in the localities which suit it best they are smaller, thinner, and smooth. A variety is found in the *Dipterocarpus* forests of Burma with large fruits and leaves, and Haines notes several varieties in his Forest Flora of Chota Nagpur, page 363.

3. Description, Properties and Uses of Timber.

The sapwood is reddish-white and narrow, the heart-wood dark-brown and hard, the annual rings being indistinct and the wood marked with wavy darker streaks. It is not easy to work and is avoided by sawyers when they can get other timber, and they demand higher rates for sawing it, as the timber is often cross-grained. The cross-section shows many regularly scattered pores arranged in short wavy lines.

Durability.—It decays rapidly as a rule when used in the open, but has been found to last well occasionally in the ground as railway sleepers, and in other exposed situations. It is much more durable when used for beams inside houses and in other airy sheltered spots. In damp badly ventilated situations it is almost sure to be attacked by dry rot which soon destroys wood which has not been antiseptically treated. The variety with leaves hoary beneath which ascends to almost 4,000 feet in the moister Himalayas has been preferred to Sal for factory and bridge work. The wood has been tested in the Lower Godavari Division in Madras to determine its power of resistance to the *teredo*. The results showed that at one station the timber was badly attacked. White-ants also usually destroy it after two or three years, when they are plentiful.

Weight.—Specimens from the south of India have weighed as much as 74 lbs. per cubic foot, but the ordinary weight, calculated from 20 specimens from all parts of India is 59 lbs. very much the same as Sal (Gamble)

Strength.—The value of P, which represents the strength of a bar of timber calculated from the length between supports, breadth and thickness of the bar, and the weight in pounds which, when placed in the middle of the bar, causes it to break, is for this timber about 827 (Gamble). For Sal it is 790, for Teak 600, and for Shisham 796.

Fissibility.—From tests made by Mr. R. S. Troup the timber appears to be fairly easily split. The figure given by a number of tests made in different ways is 4·63, Teak giving the figure 1·75, Chir pine 2, *Acacia Catechu* 2·98, and Sal 9·33.

Calorific power.—The heat-producing power of the timber is very high, being with Sal almost at the top of the list of 56 common Indian woods tested by the Forest Chemist, Mr. Puran Singh ; only two species, both conifers, are above Sal and Sain, and it is a good fuel and charcoal wood.

Seasoning.—In Central and Southern India the timber is often soaked in water for a month or two after felling and barking which is said to increase its durability. The lighter heartwood between the centre and the outer circumference also becomes darkened in colour by this means. The timber needs slow seasoning in the shade as it is apt to crack and split badly if dried too quickly. In the Central Provinces the water method is employed, and other methods in use are to bark the logs when felled during the rains and stand them up against trees for several months, or to char the logs after barking over a light fire. In Central India the wood is much preferred when felled during the rains and the natives object to felling it at any other time.

Uses.—The timber is used all over India for building purposes usually as beams, rafters, and occasionally ceiling planks. It is also used for carts, ploughs, dolls, slippers, irrigation water-wheels, bedsteads, bushing machinery, and very often as fuel. In the Central Provinces poles are in great demand by the villagers and are sold to the coal mines for pit props. At Meerut scantlings and beams are sold at R1-6 per cubic foot, but planks are not considered worth offering for sale. In 1890 scantlings 12′ × 5″ × 4″ were selling at R14 per score at Cawnpore, R35 at Bareilly, and R55 at Moradabad. In 1895 the prices were R40 at Cawnpore, R45 at Bareilly, and about R50 at Moradabad. At Kallai in Malabar the price is R2 per cubic foot for scantlings and R2-2 per cubic foot for planks free on railway trucks. Some of the hill people in the United Provinces have a superstitious prejudice against the wood and

refuse to use it. A small consignment was sold in London in 1878 for £1-15 per ton. Edward Balfour, in his book on Indian Trees published in 1862, says that it was much esteemed at that time as a building timber, being very strong and heavy, but the same defects are noted by him as prevent its use in many parts at the present day. Its price at Nagpur was then 5 annas per cubic foot. It has been frequently experimented with for railway sleepers with very varying results. In South-Western India trials on the Madras and South Indian Railway led the engineers to think that the timber was not worth experimenting with further, but this was doubtless due to the sleepers being supplied almost green, to the influence of the sea air and the heavy rainfall during the monsoon. On the Eastern Bengal State Railway much better results were obtained and the timber was described as being excellent sleeper material. The average age on the Kaunia-Dharla line of this Railway was $8\frac{3}{4}$ years, when laid in earth and carrying light traffic. On the northern section the average age was nearly 6 years. On the main line 10 per cent. of these sleepers had to be removed the year after they were laid, the ballast being shingle. The following notes were sent in by the Executive Engineer, Saidpur, in 1891 :—

4,110	sleepers	laid	in	1881	.	.	89	renewed	up	to date
2,446	„	„	„	1883	.	.	none	„	„	„
1,404	„	„	„	1885-86	.	.	119	„	„	„

In 1879 the Great Indian Peninsula Railway laid down 447 sleepers, of which 59 had decayed and been replaced in 1883, the engineer remarking that it seemed very liable to crack and be attacked by dry rot.

The approximate life of the timber as sleepers was given by the Chief Engineer, Madras and Southern Mahratta Railway, in 1910, as 5 to 10 years.

Some untreated sleepers laid down in 1907 in the Rangoon-Mandalay line were found to be sound but rather badly split at the beginning of 1911. The Bengal and North-Western Railway put down 2,665 sleepers in 1899, and had to replace 852 in 1903, the remainder being removed to an unimportant branch.

About the year 1880, a large number of sleepers were put down in the Bengal-Nagpur Railway between Umaria and Kutni but 40 per cent. had to be removed by 1893.

In 1886, 496 sleepers were laid down in the Rohilkhand and Kumaon Railway, and 57 per cent. remained sound in 1895.

4. Minor Products.

The bark is commonly used for tanning skins and preserving nets and an astringent gum is also obtained which sells for 4 annas per seer in the Central Provinces and is used for incense and as a cosmetic. The ashes of the burnt wood are used by dhobies in Oudh and the bark is sometimes used to poison fish in streams. Juice of the bark is used as an astringent in making palm sugar. In Mysore and South Kanara the natives burn the bark and prepare lime from it in an elaborate manner for the use of Jains and Brahmins (*Indian Forester*, August 1909) and it is used in the same manner by some wild tribes in Southern India. In extracts of the bark prepared in the forest by rough methods over 70 per cent. of tannin have been found, and by an analysis of bark made in Germany the following results were obtained :—

	I	II
Percentage of tannin agents	52·5	23·4
Non-tanning soluble substances	27·1	33·4
Insoluble	6·8	31·6
Water	13·6	11·6
	100·0	100·0

The extracts were reported to be too dark in colour and to have no chance of finding a market until they were decolorised. The preparation of such extracts in a rough and ready way will probably not lead to the development of any trade in Europe, as up-to-date machinery is required.

Method of tanning with Saj bark.—In this case the hide is usually treated with *kas* or liquor five times as follows :—

The first *kas* consists of 3 or 4 seers of powdered bark mixed with 20 seers of water, the second of 5 seers of bark, the third of 7 seers, the quantity of water remaining the same throughout. The hide remains in the first *kas* for 3 days, in the second 5 days, in the third 6 days, in the fourth 7 days and in the fifth 8 days, it being taken out and rubbed 3 times daily as previously noted. It is then taken out of the *kas*, washed in clean water and dried, after which it is well rubbed by hand. The leather thus prepared is of a dark, brownish-red colour, of good quality and does not crack. [*Tanning Materials used in the Damoh District, Central Provinces*, by R. S. Hole.—*Indian Forester*, July 1899.]

The fruit has been found to contain 4 per cent. of tannic acid. In Western Bengal and Hyderabad the tree is the mainstay of the *tasar* silk industry, being pollarded before the rains to provide young leaves for the caterpillars. Mr. T. F. Catania writing to the *Indian Forester* in 1899 laid great stress on the future that probably awaited the *tasar* silk industry in Hyderabad, favoured by the fact that natural jungles of *Terminalia tomentosa* extend for miles as if they had been created for the propagation of this industry. He compared the planting of millions of mulberry trees which would have had to be undertaken to feed the Univoltine variety of the silk-worm, eggs of which had been offered to the Nizam by the Indian Government. In parts of Bombay the tree is extensively lopped for ash manure for crops, the process being continued from year to year until the hills, for example in Satara, along the line of the Ghats, are studded with huge pollards (Brandis). Lac is occasionally gathered on the branches and in Oudh and the United Provinces the leaves are lopped for cattle fodder (Brandis). A number of experiments made in the United Provinces to determine the proportion of bark to wood by weight gave the following results :—

With 6 trees of 1st and 2nd girth classes, the weight of wood fit for timber and fuel being 100, the weight of dry bark was 16·5 : with 6 trees between 4′ 6″ and 8′ 9″ in girth the proportions of dry timber and dry bark were 100 to 14·6 : with 6 trees between 3′ 4″ and 8′ 0″ in girth the proportions of green wood to green bark, which in this case included the weight of unbarkable branches, was 100 to 25.

5. Natural Reproduction and Rate of Growth.

Few trees show better natural reproduction than this, both from seed and coppice shoots. Reports from nearly all districts describe it as being fair to good, and it has the advantage that young seedlings are not overcome by the coarse grass that often covers the moist flats where it attains a large size. From the United Provinces alone do the reports indicate that seedlings are not plentiful, and this may be due to the extent to which seed-bearers have been removed in order to benefit Sal. Cattle and monkeys eat it and where heavy grazing is the rule, the young trees are usually destroyed. H. H. Haines states that in the Central Provinces coppice reproduction is somewhat uncertain, especially when trees are felled in the rains, but shoots may grow to 6 feet in two

years. On the other hand numerous shoots are sometimes produced which remain small and weak and may only be a few feet high after 10 years' growth. He also makes the following note : " In the Central Provinces the main stem is frequently a sympodium made up of the lower parts of repeated leaders which have bent over at the top while lateral buds have in their turn assumed leadership." In 1895 Mr. H. C. Hill noted that this and other species formed dense thickets of seedlings in the Central Provinces where the beneficial influence of an old *mohwa* tree was found. Mr. J. W. Best notes as follows on the growth in the Bhandara Division, Central Provinces, in the *Indian Forester* for November 1909 :—

" Another phenomenon due to excessive grazing is the curious growth of young *Saj* trees. I have in many places seen considerable areas of forest, the soil of which is completely covered by young *Saj* trees up to 18 inches in height, very much branched and stunted in growth. On being dug up these plants will be found to have a thick and distorted stem at or just beneath the surface of the ground. It is possible to ascribe this condition of growth solely to forest fires.

I think that excessive grazing has more to do with it, however, because the phenomenon is as common inside forests which have been successfully protected from fire for a number of years as it is in forest where protection has not been attempted, and one would expect these young trees to recover after protection from fire for a number of years. Our best forests in Bhandara are always protected from fire, but with the exception of the small area taken up by the high forest working circle in Gaikhuri Range, none of our forests are protected against cattle-grazing for a greater period than 10 years.

In the high forest circle, where protection from cattle has been carried out for the last 11 years, this condition of the *Saj* regeneration although present is not common ; it must, however, be borne in mind that previous to protection the ground was probably grazed as heavily as elsewhere.

In places such as steep hills where, owing to their inaccessibility, cattle never graze, stunted growth of young *Saj* is absent and incidentally the regeneration of all species is in a considerably more satisfactory condition than in forests situated on level ground.

The cause of this abnormal growth of *Saj* can be ascribed not so much to the browsing of animals as to their continuous trampling. This would account for the thick stem at the surface of the ground. If stems are continually, year after year, trodden down and mutilated, they could not be expected to send out a strong leading shoot, more particularly as the soil over the roots becomes hard through continuous trampling.

On the sides of steep hills where cattle seldom if ever graze there are usually a sufficient number of stones to prevent the trampling down of the seedlings as well as of the soil, hence the comparatively good regeneration on the hillsides."

Mr. L. K. Martin is inclined to think that the above growth is produced by the persistence of the annual shoots giving a bushy appearance to the tree till eventually the root is sufficiently established and able to throw up a large strong leading shoot, which grows fast and straight, the previous shoots dying down.

Bourdillon says the rings run about 6 to an inch.

Caccia records measurements taken on 300 trees in sample plots in the United Provinces during a varying number of years, of which 17 was the most, which indicate that the mean annual girth increment varies from *nil* to 1·25 inches. The latter was recorded on trees between 1½ and 4½ feet in girth and is quite exceptionally high.

Experiments in coppice growth made by Mr. H. Murray in Belgaum in 1894 gave the following results. Three or four trees were examined and the date determined for all ages, mature trees between 38 and 44 years being selected.

Age.	Diameter in Inches.		Height in Feet.		Number of shoots per stump.	Length of bole.
	Total.	Mean yearly.	Total.	Mean yearly.		
10	4·2	·42	19	1·9	...	...
20	6·0	·30	29	1·45	...	...
30	7·8	·26	40	1·33	...	...
40	9·0	·225	50	1·25	...	30
1	...	...	...	...	9	...
40	...	...	...	...	1 to 2	30

These figures were obtained at Nagargali at 2,200 feet above sea-level : the rainfall was about 80 inches and the soil laterite with some humus. The rock was laterite overlying gneiss. The crop, in density ·9, had been fire-protected for six years and the other species were mostly *Xylia dolabriformis*, *Terminalia paniculata*, and *Lagerstræmia lanceolata*.

Mr. D. A. Thomson records the following average diameters in his Working-Plan for the Supa Fuel Reserves, Northern Kanara, Bombay :—

Age	5 years	diameter	1·159 inches.
	10 „	„	2·21 „
	15 „	„	3·23 „
	20 „	„	4·2 „
	25 „	„	5·23 „
	30 „	„	6·27 „
	35 „	„	7·265 „
	40 „	„	8·121 „
	45 „	„	9·114 „
	50 „	„	10·06 „
	55 „	„	10·08 „
	60 „	„	11·5 „
	65 „	„	11·89 „

In the Karwar Fuel Reserves he calculated that the average girth at 40 years was 28·02 inches.

Mr. R. S. Pearson gives the following figures obtained in the Ankola High Forest and Kalinaddi Slopes Forest, Kanara, Bombay :—

Age.	Average diameter in inches.	
	Ankola.	Kalinaddi.
10	2·18	2·4
20	4·0	5·7
30	5·76	8·4
40	7·46	9·9
50	9·05	12·2
60	10·55	14·2
70	11·73	15·9
80	12·8	17·6
90	14·13	18·9
100	15·51	20·4
110	16·82	21·9
120	18·1	23·2
130	19·21	24·4
140	20·75	25·5
150	21·96	26·5
160	23·10	27·3

Mr. N. D. Satarawala gives the following figures in his Working-Plan for the Khanapur Fuel Reserves, Belgaum, Bombay :—

Average girth at 40 years, 22·95 inches.

Age of coppice shoots and mid-girth in inches—

1	year	4·0 inches.
2	years	4·5 „
3	„	5·3 „
4	„	6·8 „
5	„	8·3 „
6	„	9·2 „
7	„	8·8 „
8	„	9·3 „
9	„	11·9 „
10	„	11·1 „
11	„	9·1 „
12	„	11·1 „
13	„	10·6 „
14	„	13·6 „

From countings made in the Nallamalai forests, Kurnool, Madras, the average number of rings to each inch of diameter was found to be 5.

In the Begur forest, North Malabar, Madras, 25 trees were measured and gave the following results :—

Average age at	6	inches	diameter	28·5 years.
„	12	„	„	57·8 „
„	18	„	„	85·3 „
„	24	„	„	116·6 „

In the Chedleth Range forests in the same district 77 trees gave the following results :—

Average age at	6	inches	diameter	26·05 years.
„	12	„	„	48·02 „
„	18	„	„	72·35 „
„	24	„	„	100·01 „

Mr. H. Murray records the following measurements of Coppice shoots in Belgaum, Bombay :—

Age.	Height. Feet.	Diameter. Inches.
5	11	2·3
10	19	4·1
15	25	5·1
20	30	6·1
25	35	6·9
30	40	7·7
35	45	8·4
40	50	9·0

Mr. F. Foulkes in "Notes on Timber Trees—South Kanara" says :—

"Except in rigidly fire-protected areas, very little of the January seed crop survives as the hot weather fires destroy it. Apart from the fact that it is a strong shade-bearer and has large annual seed crops, the exceptional facility with which this tree reproduces itself is due to the July seed crop.

The rains begin in the middle of May and culminate in July, consequently there are no fires anywhere then.

The chief danger the seed runs is from rotting and not being able to secure a lodgment owing to the torrents of water which come down. Cattle must be rigidly excluded from areas under reproduction, and in the plains forests, fires also.

Seedlings become established in 3 to 5 years.

This species coppices excellently, but unless cut quite flush with the ground, the shoots are apt to grow horizontally instead of straight up."

6. Artificial Reproduction.

Sowing and planting has been tried in all provinces with good results on the whole. There seems to be no difficulty in obtaining a high percentage of germination, and the seedlings may reach a height of 18 inches after the first rains. In the Bombay Presidency in order to fill up blanks in coupes, small pits have been dug and the seed sown in them has germinated well. Where transplanting of one-year old seedlings has been tried, many of them have died and white-ants have attacked the roots. In plantations made in Burma deer at once selected the young seedlings in the forests for food, and in Bombay pig did an equal amount of damage.

7. Notes on Distribution and Extraction in different Provinces.

(*i*) *Burma.*

Vernacular names.—Taukkyan (Burmese), Dap (Kachin), Mai'hok-hpa (Shan), Thay-hpay-kala (Karen), Taukkran (Arakanese).

Local distribution.—This tree is one of the commonest in the Province and occurs in considerable quantities almost everywhere except in the Northern Shan States, Arakan and the South of Tenasserim where it is scarcer. In Upper Burma it seems to ascend commonly to a much greater height than in Tenasserim, being reported from an elevation of 4,000 feet in the Southern Shan States and 3,000 feet from

Bhamo. In the sea-coast districts it does not appear to go beyond 1,000 feet, but on the whole it grows best at 500 to 1,500 feet above the sea.

A stiff clay suits it well but it grows on many other varieties of soil, stunted but in considerable numbers on laterite and in dry stony *Indaing*, straight and tall on well-drained ridges with *Dendrocalamus strictus* and *Bambusa polymorpha* and in plains forests, and fairly densely on moist flats. Excellent groups may be found in most of the Pegu Yoma and Upper Burma bamboo and teak forests, containing trees up to 12 feet in girth, with a clear bole of 60 feet and height up to 120 feet, but the size of tree principally in evidence has a girth of 5 to 8 feet.

Extraction.—Except in the dry zone and a few of the more remote divisions, little difficulty will be found in extraction to the Railway or a floating stream, the logs being dragged by buffaloes or elephants from the hills and thence carted. With the aid of bamboos the timber can be rafted down the Chindwin or the Irrawaddy as well as smaller streams, and it is still to be found in Upper Burma close to the banks of these rivers in large quantities. No extraction is done by Government, and in nearly all the Government Reserves, trees will be marked to suit the convenience of purchasers, the duty never totalling more than R6 per tree. In unreserved forests also little restriction is placed on extraction, except in some districts where the best trees in the easily accessible forests have all been felled. The amount extracted up to date cannot be correctly estimated, no separate records for this timber having been kept, but an ample supply is still available in all the divisions named in the table below. A few estimates of quantities in the forests obtained from their Working-Plans are given below. In most districts will be found traders who are well acquainted with the best method of arranging for the extraction of timber to a floating or railway station and the purchaser can always get into touch with them through the divisional officers whose address is given in the table below. Divisions in which extraction is very difficult are not entered. The log referred to in the table measures over 4′ 6″ in mid-girth without bark and may be of any length that the buffaloes and carts can manage. The ton represents 50 cubic feet in the round, unless "converted" is entered. The figures given under local market rates and rates for delivery are in many cases only estimates, the timber having been little extracted up to date over the greater part of Burma. The duty must usually be added, but it is hardly ever more than R2 per ton for round logs, and R4 per ton for sawn timber.

Division.	Government duty per log.	Local market rate.		Rate for delivery.			Headquarters of Divisional Forest officer.
	R a.	R	Per	R	Per	At	
Upper Chindwin.	1 0	...	...	10	ton	Alon	Kindat.
Lower Chindwin.	1 0	...	...	10	ton	Alon	Monywa.
Myittha	1 0	...	...	14 30	ton ton	Alon Rangoon	Mingin.
Bhamo	1 0	...	...	20 25 40	ton	Katha Mandalay Rangoon	Bhamo.
Katha	1 0	10	ton	10 15 35	ton	Katha Mandalay Rangoon	Katha.
Mu	1 0	12 30	log ton converted.	15 40	ton ton converted	Kanbalu or Wuntho.	Shwebo.
Ruby Mines	1 0	6	log	13	ton	Mandalay	Mogok.
Mandalay	1 0	50	ton converted.	35 45 35	ton ton converted ton	Thazi Mandalay	Maymyo.
Minbu	1 0	...	...	25	ton	Irrawaddy bank.	Minbu.
Pyinmana	1 0	35	ton converted.	35	ton	Pyinmana and other stations.	Pyinmana.
Thayetmyo	1 8	...	...	12 15	ton ton	Irrawaddy bank. Rangoon	Thayetmyo.
Prome	1 8	...	...	6	ton	Prome and other stations.	Prome.
Henzada	1 8	10	log	20 50 26 56	ton ton converted ton ton converted	Kyangin and other stations. Rangoon	Henzada.
Bassein	1 8	9	log	8	log	Bassein	Bassein.

Division.	Government duty per log.	Local market rate.		Rate for delivery.			Headquarters of Divisional Forest officer.
	R a.	R	Per	R	Per	At	
Zigon . .	1 8	...	...	3	log	Zigon . .	Tharrawaddy.
				14	ton	Rangoon . .	
Tharrawaddy .	1 8	7	log	40	ton converted.	Letpadan and other stations.	Tharrawaddy.
				53	do.	Rangoon . .	
Arakan .	1 8	75	ton converted.	75	ton converted.	Kyaukpyu or Chittagong.	Akyab.
Rangoon .	1 8	6	log	5	log	Palôn and other stations.	Rangoon.
		40	ton converted.	40	ton converted.	Do. .	
				50	do.	Rangoon .	
Pegu . .	1 8	20	ton	20	ton	Pegu . . .	Pegu.
Toungoo .	1 8	35	ton	8	ton	Toungoo and other stations.	Toungoo.
Shwegyin .	1 8	45	ton converted.	15	ton	Railway stations	Shwegyin.
				10	ton	Shwegyin .	
Ataran . .	1 8	...	...	50	ton converted.	Martaban or Moulmein.	Moulmein.
Thaungyin .	1 8	...	,,	11	ton	Martaban or Moulmein.	Moulmein.

Figures from Burma Working-Plans.

District.	Working Circle.	Area in square miles.	Trees on the area. Girth in feet. Above 7.	6—7.	4½—6.	3—4½.	Remarks.
Tharrawaddy .	Satpok . .	8	3,158	3,623	5,881	8,756	The minimum girth limit fixed for felling is 6 feet.
Do. .	Sitkwin . .	2	347	271	725	1,250	
Do. .	Thindawyo .	10	762	779	906	1,509	
Do. .	Kangyi . .	8	2,537				

(*ii*) *Central Provinces.*

Vernacular names.—Ain (Marathi), Saj, Saja or Barsaj (Hindi), Maddi karra (Telegu).

Local distribution.—This tree occurs in almost all the forest tracts of the Central Provinces and is often the commonest. It is inclined to be gregarious and attains large girth in the moist fertile flats and especially affects *nalas*. Where Sal occurs it is found with it and thrives between 500 and 2,000 feet above sea-level, small trees ascending to 3,000 feet, and is also found in teak forest in some districts. It often forms 10 to 30 per cent. of the standing crop and occasionally as much as 50 per cent. and stunted trees are abundant on black cotton soil, which many species do not like.

Extraction.—The forests containing this species are nearly always worked under the Coppice with Standards method, but in Mandla, part of South Chanda, part of Seoni, Chindwara, and Hoshangabad the yield is principally derived from Improvement fellings. The sizes of timber obtainable accordingly vary much and rates for different kinds are given in the table below. At present the market value of the timber is not great enough to bear the cost of transport from the more remote forests, and roads or tramways would be able to tap rich areas still almost untouched. The Coppice with Standards coupes are usually sold as they stand to purchasers, but departmental extraction is carried on in a few districts.

From the figures given in the table will be seen the approximate amount of timber available, but no accurate returns for past extraction, and no further estimates of any value for future outturn can be given at present.

Very little has been exported from these Provinces up to date.

Division.	Government duty.		Local market.		Rate for delivery.		
	R a. p.	Per	*R a. p.*	Per	*R a. p.*	Per	At
Mandla . .	0 2 9	c. ft.	0 4 0	c. ft.	1 15 0	c. ft. round.	Bombay.
					2 3 0	c. ft. converted.	Bombay.
					0 8 0	c. ft. round.	Railway stations.
					0 12 0	c. ft. converted.	Railway stations.
Damoh . .	...	...	12 0 0 to 25 0 0	100 poles	0 2 0	c. ft.	Railway stations.
					0 5 0	„	Jubbulpore.
					0 13 0	„	Bombay.
Saugor . .	...	...	0 4 0 to 0 12 0	pole	0 4 0	c. ft.	Railway stations.
					1 0 0	„	Bombay.
Narsingpore .	...	...	2 0 0 to 60 0 0	100 poles	1 0 0	c. ft.	Railway stations.
Seoni . .	...	...	0 1 6 to 3 4 0	pole	...	...	.....
S. Chanda . .	0 2 0	c. ft.	...	...	0 7 0	c. ft.	Rajahmundri or Cocanada.
					0 11 0	„	Nagpur.
					0 14 0	„	Cawnpore or Bombay.
Nagpur Wardha	...	...	7 8 0 to 20 0 0	100 poles	0 2 6	c. ft.	Railway stations.
Bhandara . .	...	...	2 0 0 to 10 0 0	100 poles	0 6 0 to 0 12 0	c. ft.	Railway stations.
Balaghat . .	0 0 9 to 0 10 0	pole	...	...	10 0 0 to 75 0 0	100 poles	Railway stations.
					0 12 0	c. ft.	Lamtha station.
Raipur . .	...	...	7 0 0 to 60 0 0	100 poles	0 5 0	c. ft.	Dhamtari or Rajim.
			0 3 0	c. ft.			

In Working Circle No. 1, Allapili Forests, Chanda, Central Provinces, the following figures are given, the area being 31 square miles :—

Number of sound trees above 24 inches diameter . . . 7,473

„ „ „ 18—24 „ „ . . . 15,888

The minimum limit for felling is 24 inches diameter.

(*iii*) *Central India Agency.*

In the State of *Rewah* the tree is common, and grows to about 4 feet in girth. It is used by the villagers for building, but little has been

exported. The royalty is 2 annas per cubic foot and about 10,000 cubic feet are available annually near the Railway line.

In *Gwalior* the tree occurs with teak and other species over a large area, but only as coppice shoots from old stumps. It is much in demand by villagers and the royalty charged is R3 per cart-load or 2 annas per cubic foot. It is called *Saj* in Malwa and *Sader* in other parts.

In *Indore* it is abundant everywhere, but attains large dimensions only in a few favoured localities along the Satpura Hills on the borders of Khandesh, where tall straight trees of 7 feet girth are sometimes found. It grows to 4 or 5 feet in girth in the south-west of Nimawar, near the Chandgurh Reserve, Central Provinces, but such trees contain little heart-wood. The timber always commands a fair price for local building purposes and is valued for shafts. Small poles of a girth of less than 18 inches are scarcely saleable, but it is used for ploughs, agricultural implements, fuel and charcoal and the bark is valued for tanning. It is called *Sadar, Saj,* or *Sajada.*

(*iv*) *Berar.*

Vernacular names.—Sajar, Saj, Sadora, Ain.

Local distribution.—Only in Betul, Nimar and Melghat does this tree grow to a large size, 6 to 8 feet in girth with a 50 feet bole, but individuals of this size are not common, and it is frequently stunted and shrubby owing to the poverty of the soil. It is however fairly abundant, forming up to 20 per cent. of the crop in favourable valleys. On the flat plateaux on the basalt it is little more than a shrub.

Extraction.—Most of the wood is felled small in Coppice forests but large timber is removed in Improvement fellings from Betul and Melghat in the north of Berar, and it may be anticipated that a fairly large quantity of timber will be available for export from these forests when the new railway in the north of Berar has been built. Most of the extraction will be done by carts, dragging from the stump being necessary in the hilly tracts. In Betul an estimate has been made that 20,000 cubic feet will be available annually, two annas per cubic foot royalty being charged on the outturn, all work being done by the purchaser. From the Melghat forests timber can be delivered at Amraoti for R11 per cart-load of 6 maunds, the rate for the same to Ellichpur being R8. From the Betul forests timber can be carted to Itarsi in the Hoshangabad district for R5 per cart-load of 15 cubic feet.

(v) *Punjab and Kashmir.*

Vernacular names.—Sain, Assam.

Local distribution.—In the Kangra and Simla forest divisions only is this tree reported to occur to any extent and even there it is not important at present. From the Submontane forest of the Simla Division the cost of carriage is so high that even Sal has not so far been much exported and in the Kangra hills it is confined to scrub forests and has rarely been extracted. It can be delivered at Jagadhri for about 10 annas per cubic foot, at Jullundur for Rl and at Hoshiarpur for 12 annas per cubic foot of sawn timber.

In *Jammu* and *Kashmir* it is called *Bahera* and is found in the outer valleys of the Jammu Province below 2,000 feet, usually scattered in cultivation and rare in forests. It attains a girth of 6 feet, occasionally more, and is used in the construction of village houses and for agricultural implements.

(vi) *Eastern Bengal and Assam.*

Vernacular names.—Amari, Asna, Sain, Paka Saj, Asan.

Local distribution.—The tree is rare almost all over this province, and does not occur in many of the forests at all. It appears to be common only in the Jalpaiguri forests adjoining north-eastern Bengal and is there found up to 700 feet above sea-level, usually in mixed forests and rarely with Sal, trees 8 feet in girth being found with a clear bole of 40 feet. It can be extracted to railway stations for about 8 annas per cubic foot in the round, and to Calcutta for about Rl-4 per cubic foot in the round and Rl-10 sawn, but very little indeed has been sold up to date.

(vii) *United Provinces.*

Vernacular names.—Saj, Asna, Sain, Asaina, Hasna, Turha (Bundelkhand).

Local distribution.—The *Sain* trees is, after Sal, one of the most important timber trees of the United Provinces, and occurs in considerable numbers in almost all the Sal and many of the mixed forests and in the lower hills up to an altitude of 4,000 feet. It usually favours clayey localities on which it produces its best growth, and occasionally occurs pure over small areas. In the best Sal forests of these provinces *Sain* attains at times a girth of 13 feet with a clear bole of 50 feet, and many good trees of 6 to 8 feet in girth may be found. Under the various Working-Plans in force the exploitable size is fixed at 6 or 7 feet, the number of *Sain* trees

estimated to be available being very large. They are shown in the tables below.

Extraction.—Trees are felled almost entirely under the Selection method, being chosen either specially for purchasers or in the course of Improvement fellings undertaken in order to favour the Sal. All trees marked on certain defined areas are sold annually to purchasers who pay either a lump sum only, or a lump sum combined with royalty on outturn, exporting the timber partly in the round and partly converted, by coolies or buffaloes to the nearest cart-road. Sawyers must often be imported and get ₹10 to 15 per month and food. It is accordingly necessary for purchasers to inspect the coupes before purchase in each case. Except Naini Tal, Chakrata, Bundelkhand, and Pilibhit, each forest division can supply a considerable quantity of *Sain* timber annually for some time to come, the estimated cost and amount available being given below:—

Forest Division.	Rate for delivery without royalty.			Amount available annually.	Amount extracted during last 5 years.
		Per	At	C. ft.	C. ft.
Gorakhpur .	4 annas	c. ft.	Pharenda .	1,20,000	6,00,000
	7 do.	do.	Siswa Bazar .		
	8 do.	do.	Gorakhpur .		
Gonda . .	5 do.	do.	Railway stations	20,000	91,000
Bahraich	6 do.	do.	Nishangara .	50,000	2,16,000
	8 do.	do.	Raibojha .		
	10 do.	do.	Bahraich .		
	13 do.	do.	Bahramghat .		
Kheri . .	8 do.	do.	Sarota Phanta .	1,00,000	5,40,000
	5 do.	do.	Chandan Chowki		
Haldwani .	3 to 5 annas.	do.	Haldwani and Lalkua.	40,000	2,00,000
Lansdowne .	.....	...	... ...	60,000	1,00,000
Ramnagar .	10 to 12 annas.	do.	Nagina, Dhampur, Seonara,	...	23,000
	8 to 10 annas.	do.	Ramnagar.		
Siwaliks (Dehra Dun).	8 annas sawn.	do.	Railway stations	12,000	61,000

Figures from Working-Plans in the United Provinces.

Forest Division.	Working Circle.	Area in square miles.	Number of sound trees on the area. Girth in feet. Over 6 feet.	Number of sound trees on the area. Girth in feet. $4\frac{1}{2}$ to 6 feet.	Minimum girth fixed for felling.	Annual yield.
Haldwani .	Sarkhet .	37	5,094	8,350	6 feet.	141 trees.
	Nandhaur .	65	15,847	28,709	,,	440 ,,
	Kalaunia .	59	19,593	24,245	,,	544 ,,
Ramnagar .	Taria . .	64	16,717	32,543	,,	464 ,,
	Ramganga .	28	11,540	9,856	,,	..
	Kotah . .	35	556	2,002	,,	...
Lansdowne .	Palain .	44	3,817	8,504	,,	106 trees.
	Sona Nadi .	21	1,032	1,836	,,	...
	Kohtri .	14	1,592	3,921	,,	...
Bahraich .	Motipur Sal .	64	5,040	15,101	,,	...
	Chakia Sal .	6	544	4,292	5 feet	...
	Sohelwa Sal .	18	6,683	6,271	6 feet	...
Siwaliks (Dehra Dun).	Experimental	8	464	590	..	...

(*viii*) *Western India.*

Vernacular names.—Matti, Sadad or Sadado (Gujarati), Kari-Matti (Dharwar), Ain (Thana and Kolaba) or Ains.

Local distribution.—The tree is reported to be abundant in all the forest tracts except Satara and Belgaum forming up to 50 per cent. of the crop in parts of the Thana district and occurring to the extent of 30 mature trees per acre in parts of the Dangs forests in Surat. In Kolaba lopping for ash manure for rice cultivation has almost exterminated it in certain parts. Its northern limit seems to be 24° as it does not occur in Sindh and Rajputana, but in Kanara it is very plentiful. From the Dangs forests in Surat it forms the bulk of the yield of jungle-wood. Although apparently attaining its largest size, 8 feet in girth, 100 feet in height, with clear bole of 60 feet, only on flat fertile areas, it is found in almost all classes of forest from 100 to 2,500 feet above sea-level. It is generally smaller than this, and is usually much less of a timber tree near its northern limit.

Extraction is carried on by dragging with bullocks and carting, the work being done partly by contractors and partly by Government agency. The outturn is obtained under the various methods of treatment under the Selection, Coppice, or Coppice with Standards systems, but the latter appears to be the commonest, the amount of large timber available being therefore not great. In Khandesh, Panch Mahals, Dharwar, South Thana and Kolaba the wood is principally disposed of as fuel. From three of the Kanara divisions the annual total average outturn of recent years has been about 50,000 cubic feet. In the table given below the figures available for timber have been entered, fuel not being included. A ton means 50 cubic feet.

In the *Rajpipla* State the tree is common, attaining a girth of 42 inches, and being at times as plentiful as 30 trees to the acre. The quantity available annually in future is estimated at 15,000 cubic feet. It is extracted by the Bhils and a good deal can be floated down the Nerbudda. The rates given for this State in the table below refer to rough logs and should be quadrupled for converted timber. It is at present exported to Baroda, Ahmedabad and North Gujerat.

In *Baroda* it sells for ₹3 per cart-load of timber, and six annas per cart-load of fuel.

Division or State	Government duty.		Local market rate.		Rate for delivery.			Outturn.	
	₹ a.	Per	₹ a.	Per	₹ a.	Per	At	Quantity.	During
W. D. Kanara	...	...	53 0	Ton	5 0	Khandy	Sea-coast .	82,000 c. ft.	Last 4 years.
E. D. „	24 0	Ton	40 0	„	55 0	Ton	Hubli or Hattikeri.	78,000 c. ft.	„ 5 „
S. D. „	24 0	„	1 0	C. ft.	0 8	C. ft.	Bombay, Calicut.	...	...
					0 4	„	Hanawar.		
N. D. „	24 0	„	1 0	„	0 4	„	Haveri . .	41,000 c. ft.	Last 3 years.
Dharwar (small timber only).	...	...	2 0 0 12	Pole stack of fuel 6′ × 5′ × 4′.	0 2	„	Hubli	7,000 poles.	„ 5 „
Surat . .	...	...	15 0	Khandy .	11 0 12 0 13 0	Khandy of 12½ c. ft.	Tapti Valley Railway. Bulsar Surat.	25,000 c. ft.	„ 5 „
Rajpipla State	0 2	C. ft.	0 8	C. ft.	0 8	C. ft.	Nandod or Chandod	88,000 c. ft.	1904 to 1909.
					0 10	„	Ankleshwar.		

Figures from Bombay Working-Plans.

District.	Working Circle.	Area in square miles.	Trees on the area.	Minimum size fixed for felling.	Remarks.
Kanara . .	Gund, Series X and XI.	47	1″ to 24″ diameter . 100,000 Above 24″ diameter . 12,000	24 inches diameter.	
„ . .	Supa, block XX	18	10″ to 24″ diameter . 57,000 Above 24″ „ . 2,000	6 feet girth.	
„ . .	Kalinadi slopes, block XXVI.	42		*sound.* *unsound*	
			7″ to 27″ diam. 84,000 15,000 Above 27″ „ 3,500 1,000	7 feet „	Annual yield 110 trees.
„ . .	Mundgod High Forest.	85	4″ to 24″ diameter . 900,000 Above 24″ „ . 19,000	6 „ „	
			sound. *unsound.*		
„ . .	Ankola High Forest.	70	7″ to 27″ diam. 229,000 53,000 Above 27″ „ 9,900 13,300 (The value of the unsound trees is 10 to 15 per cent. less than that of the sound trees.)	7 feet on best locality, 6 feet elsewhere.	Annual yield 470 trees. Total number available: 1st quality 13,732, 2nd quality 4,756.
„ . .	Yellapur above ghat.	137	10″ to 24″ diameter 1,200,000 Above 24″ „ 96,000	7 feet girth.	
„ . .	Yellapur slopes	37	1″ to 24″ „ 140,000 Above 24″ „ 11,000	...	
Belgaum . .	Nagargali Series.	14	1″ to 24″ „ 23,000 Above 24″ „ 600	24½ inches diameter.	Annual yield 24 trees.

(*ix*) *Bengal.*

Vernacular names.—Paka Saj (Nepalese), Asan (Hindi), Hatana (Ho, Kol, Mundari, Santali).

Local distribution.—In Bengal and Orissa the tree is not as abundant as further south. It was formerly found often with Sal but has been killed out here and there to favour the latter. There is still, however, a great deal of marketable timber available growing usually on clay soils but ascending into the drier gravelly hill areas up to 3,000 feet above sea-level. In the Tista forests the girth reaches 16 feet with a clear bole of

70 feet but this is rare, and in the south of the province the girth is much less, rarely going above 3 feet in Palamau, and in Singhbhum being usually not more than 6 feet, with a bole of 80 to 100 feet.

Extraction.—As in Burma, the tree has been left alone in the more remote forests, having no saleable value in the Kurseong and other forests of the north. The limit of girth to be felled has been fixed as low as five feet in parts of Orissa, rising to seven feet in the north, and at these limits trees are marked for purchasers as they are required, only a small amount being available from regular fellings of Coppice and Coppice with Standards. The logs are usually dragged by buffaloes to country cart-roads, and thence carted, but occasionally they are floated lashed to boats. The estimates given of the timber now standing in the forest are extremely vague, but when the wood becomes readily saleable, a certain amount will be available annually. Two or three days' inspection of the forests of a division would suffice to enable the purchaser to decide whether the trade was worth embarking on, in any of the divisions named in the following table :—

Division.	Government duty.		Local market rate.		Rate for delivery.			Amount extracted during last 5 years.
	₹	Per	₹	Per	₹	Per	at	Cubic feet.
Angul . .	9 pies to 3 annas.	cubic foot	8 to 10 annas.	cubic foot	8 to 10 annas.	cubic foot in the round.	Cuttack .	21,000
Chaibassa .	...	...	...	...	8 to 12 annas.	do.	Lota Pahar .	..
Kurseong .	3 annas	cubic foot	...	...	12½ annas	do.	Siliguri .	...
Tista . . .	1 anna 6 pies to 2 annas according to locality.	cubic foot	10 annas to R1.	cubic foot	14 annas to R1.	cubic foot converted.	Bagrakote, Dam Dim, or Mal Bazaar, Siliguri.	15,000
Darjeeling .	...	...	...	...	8 to 10 annas.	cubic foot in the round.	Siliguri .	...
Sambalpur .	4 annas	cubic foot	12 annas	cubic foot	R1 12 annas.	cubic foot. do.	Calcutta Railway stations.	...

(*x*) *Southern India.*

Vernacular names.—Karimarudu (Malayam), Matti or Banapu (Canarese) Nallamaddi or Inamaddi (Telegu), Sahajo (Uriya).

Local distribution.—In the Madras Presidency the tree is fairly well distributed, but in the south it only occurs along hills to any extent, being absent in Tanjore and Trichinopoly. Though not so common as in Bombay, it forms in some districts up to 12 per cent. of the growing stock being fairly plentiful in the Wynaad and ascending to 4,200 feet in the Nilgiris. The girth seems not to exceed 9 feet and the length of bole 50 feet, and this size is only attained on the best favourable localities, as in Bellary, Cuddapah, Nellore, Kistna and South Kanara the best trees are much smaller. In Guntur it is absent. Mr. A. W. Lushington notes that in the hills of North Coimbatore it is chiefly confined to the higher and damper localities. It was tried for sleepers but most of the trees were found to contain heart-shakes, probably caused by the devastating fires.

Extraction.—In Kistna, Coimbatore and South Kanara a certain amount of the wood is felled in Coppice and Coppice with Standards forests as fuel, and elsewhere felling up to date has been confined to scattered Selection fellings as desired by purchasers. No large quantities have however been extracted nor can a heavy annual outturn be expected in future. From most of the forest divisions the estimates of future outturn are too small to be worth considering, but for such as have supplied details the figures in the following table may be useful. The Malabar Timber Yard and Saw Mills Limited quote R2 per cubic foot for scantlings and R2-2 per cubic foot for planks free on rail at Kallai. They call it Malabar walnut.

In *Coorg* the tree is known as *Matti* and is the predominant species in the deciduous forests everywhere, attaining in the south a girth of 10 feet. The timber is very largely used for house building and carts. About 20,000 cubic feet are estimated to be available annually, Government royalty being imposed at 3½ annas per cubic foot.

In *Hyderabad* it is called *Nalla muddy, Sadora, Saj, Yen, Kari Muddy, Kari Matti* and it is very largely used for house building. The bark is much used for tanning and the tree is pollarded for *tasar* silk cultivation by jungle tribes. It attains 6 feet in girth in Telingana and 3 feet in Aurangabad. At Warangal railway station the market rate is about R1-4 per cubic foot. From the Warangal, Karimnagar and Adilabad forests about 10,000 cubic feet have been and can be obtained annually.

In *Mysore* the tree is widely distributed and is called *Karimatti*. It is very largely used in building, for agricultural implements, and for ships and boats, and grows to a large size in Malnad. The leaves are used for manure.

About 100,000 cubic feet may be extracted annually, the price being 12 annas per cubic foot.

In *Travancore* the tree is usually called *Thembavu* and is in great demand for house building, carts, furniture, fuel, and charcoal. It is very common throughout the State between sea-level and 2,000 feet. About 150,000 cubic feet are felled annually and its value in the log on the coast is 12 to 14 annas per cubic feet (Bourdillon).

Division or State.	Local market rate.		Rate for delivery.			Amount extracted during last 5 years.
	R	Per	*R*	Per	At	Cubic feet.
North Malabar	...	...	10 annas	cubic foot	Calicut, Tellicherry and Mysore.	22,000
South Malabar	...	...	4 annas	do.	Ferok, Beypore, Calicut. Add duty on or value of timber.	84,000
North Coimbatore.	12 annas to R1.	cubic foot	10 annas	do.	Railway stations .	...
		do.	R1 .	do.	Coimbatore, Palghat, Calicut, Bangalore.	...
South Coimbatore.	7 to 10 annas.	do.	R1 .	do.	Podanur . .	59,000
Nilgiris .	11 annas in 1909.	cubic foot squared.	R1 .	cubic foot sawn.	Nanjangud . .	3,000
			R1-4 .	cubic foot sawn.	Ferok . . .	...
Vizagapatam	12 annas	cubic foot round.	15 annas	cubic foot	Narasapatam Road.	...
	R1-2 .	cubic foot squared.	R1-2 .	do.	Vizagapatam .	...
Coorg . .	4 annas.	cubic foot	11 annas	do.	Paschimavahini Station.	94,000
					Mysore . .	...
Mysore .	12 to 15 annas.	do.	13 annas	do.	Railway stations.	250,000 (3 years).

From the Coorg Working-Plans the figures given below have been taken. As, however, the Working-Plans have mostly expired, the figures must be taken merely as a guide to the amount of timber the forest can produce, and up-to-date estimates should be obtained from the Deputy Conservator of Forests, Coorg.

Name of Forest.	Area in square miles.	Quantity in cubic feet available annually.
Devamachi-Mawkal	28	3,000
Nalkeri-Hatgat	83	34,100
Anekadu-Attoor	20	800
Arkeri	29	3,000

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Forest Bulletin No. 19 1913

NOTE ON BENTEAK OR NANA WOOD

(*Lagerstræmia lanceolata*, Wall.)

BY

A. RODGER, I.F.S.

CALCUTTA
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1913

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NOTE.

THESE notes regarding the lesser known Indian timbers have been compiled in order that all the information at present available regarding them may be easily obtainable.

For some of the best forests detailed Working-Plans have not yet been made, as the demand for timber in the neighbourhood is at present very small, but full information regarding the timbers available and means of extraction can always be obtained from local forest officers.

Application can also be made at any time to the Forest Economist, Dehra Dun, United Provinces, India, who will supply specimens of any timber free and put enquirers in communication with local forest officers.

Notes on the following timbers have now appeared :—

1. Lagerstrœmia tomentosa (*Leza*—Burma).
2. Dipterocarpus tuberculatus (*In*—Burma).
3. Pterocarpus dalbergioides (*Padauk*—Andaman Islands).
4. Pterocarpus macrocarpus (*Padauk*—Burma).
5. Carallia integerrima (*Maniawga*—Burma).
6. Diospyros Kurzii (*Zebra Wood*—Andaman Islands).
7. Berrya Ammonilla (*Petwun*—Southern India and Burma).
8. Terminalia tomentosa (*Saj, Sain, Taukkyan*—India and Burma).
9. Gmelina arborea (*Gumhar, Siwan*—India and Burma).
10. Ougeinia dalbergioides (*Sandan, Tiwas*—India).
11. Lagerstrœmia lanceolata (*Benteak, Nana*—Southern India).
12. Anogeissus latifolia (*Bakli, Dhaura*—India).
13. Pterocarpus Marsupium (*Honné, Vengai*—India).

Reference is also invited to the following :—

A Manual of Indian Timbers, by J. S. Gamble, C.I.E.
(Sampson Low, Marston & Co., London.)

Indian Woods and Their Uses, by R. S. Troup.
(Superintendent, Government Printing, India, Calcutta.)

Benteak or Nana Wood.

Lagerstræmia lanceolata, Wall.

Natural Order—Lythraceae.

BENTEAK OR NANA WOOD.

Lagerstrœmia lanceolata, Wall.

Natural Order—Lythraceæ.

1. General Distribution.

This valuable tree is only found over a small part of the forest area of India, being confined to the southern and central parts of Bombay and the southern and western parts of Madras, and to Mysore. It is not recorded from Hyderabad or the Northern districts of Madras, and only scattered trees are found in Kolaba and Surat on the West Coast. In Satara and Baroda it does not occur and in East Khandesh it is very rare. In Coorg it is fairly plentiful and large in deciduous forests.

2. Locality and Habit.

The tree occurs in mixed deciduous forests up to about 4,000 feet above sea-level and grows fast in moist localities, forming as much as 10 per cent. of the stock. It grows best as a rule between 1,000 and 3,000 feet above sea-level, but in South Malabar it is reported to be plentiful between 100 and 500 feet.

It is a tall straight tree with rather an open crown of small leaves, the small white flowers appearing in the dry season at the end of the branchlets in large panicles. The bark is smooth and white and peels off in papery flakes.

"Is readily distinguishable in the forest from other trees by the peculiar colour and smoothness of its bark. Young Benteak also stands out very conspicuously from the surrounding growth by the white under-surface of the leaves showing when ruffled by the wind." (*Notes on Timber Trees in South Canara*—F. Foulkes.)

3. Description, Properties and Uses of Timber.

The heartwood is red or reddish-brown of very uniform appearance on a vertical section, moderately hard and close-grained. The annual rings may usually be distinguished, the spring wood being marked by

numerous large pores and pale colour and the autumn wood by its darker colour and short pale lines of tissue containing pores. It is straight-grained and easily worked.

Durability.—The wood is not much attacked by white-ants, specimens tested being almost sound after 2½ years in the ground.

Weight.—The wood is not very heavy, the weight per cubic foot when dry averaging about 44 lbs. Coimbatore and Malabar specimens have been found as heavy as 50 lbs. (Gamble).

Strength.—The value of *F*, which represents the strength of a bar of timber calculated from the length between supports, breadth, and thickness of the bar, and the weight in pounds which when placed in the middle of the bar causes it to break, is about 560 (Gamble). Sal gives 790, Teak 600 and Shisham 796.

Fissibility.—The wood can be fairly easily split. The figure representing its place in a list of 62 woods tested is 4, about the same as Padauk, Toon and *Terminalia tomentosa*. Sal is represented by 9·33 and Teak, which is very easily split, by 1·75.

Calorific power.—No figures are available for this species, but two other species of *Lagerstræmia* tested by Mr. Puran Singh gave fairly good results, being placed about half-way on the list of 56 Indian species tested. It makes good fuel and charcoal.

Seasoning.—In Kanara the tree has been girdled three years before felling, but this has not been found very successful in preventing cracking. The timber is very liable to this defect and slow and careful seasoning must be undertaken to prevent it. Much better results have been obtained by felling the trees ten months after girdling and storing them for eighteen months in a depôt before sale. Only 67 out of 297 trees thus treated were cracked. This was done in Kanara, Bombay (W. A. Miller).

Uses.—This timber is much in request wherever it can be obtained, for buildings, ships and furniture. In Northern Bombay small timber is converted into charcoal in the forest or exported as firewood. In Kanara straight poles sell well for masts, and it has been used for railway goods wagons. In Madras it is also used for agricultural implements and carts. Arabs buy it from Malabar for dhow-building, and it makes good coffee-cases. In Travancore it is used for oil casks.

A small consignment was sold in London in 1878 for £2 per ton.

4. Minor Products.

In an analysis of liquid extract obtained from the bark from Coorg the percentage of dry extract was found to be 1·1, the percentage of tannin ·31, and the percentage of tannin in the dry extract 28·1. It is noted by M. Rama Rao as an associate of Sandal, but root attachments between the two have not been found.

5. Natural Reproduction and Rate of Growth.

Natural reproduction is reported to be generally good, though often scattered. Foulkes in " Notes on Timber Trees in South Kanara " says :— " Natural reproduction uncertain and this species must be rigidly protected from fire as the seeds fall in the middle of the fire season : the seedlings too are especially susceptible to damage from this cause. Will not germinate in poor soil exposed to the sun but requires one that is deep, moist, and stiff : owing to the minuteness and consequent lightness of the seed it would seem to be advantageous to remove all dead leaves prior to the fruiting season in order that the seed may come into immediate contact with the mineral soil. The seedlings appear to require three years to establish themselves, and once established, are hardy."

Bourdillon says the growth is fast in favourable circumstances, young trees showing as much as 10 inches diameter in 11 years.

Experiments on coppice growth made by Mr. H. Murray in Belgaum in 1894 gave the following results. Three or four trees were examined and the data determined for each age, mature trees between 38 and 44 years being selected.

Age.	Diameter in inches.		Height in feet.		Number of shoots per stump.	Length of bole.
	Total.	Mean yearly.	Total.	Mean yearly.		
10	3·7	·37	19	1·9	...	...
20	5·5	·275	26	1·3	...	...
30	8·4	·28	34	1·13	...	..
40	9·7	·242	39	·97	...	27
1	...	...	...	...	7	...
40	...	...	...	...	2 to 3	27

These figures were obtained at Nagargali at 2,200 feet above sea-level: the rainfall was about 80 inches and the soil laterite with some humus: the rock laterite overlying gneiss. The crop, in density ·9, had been fire-protected for six years and the other species were mostly *Xylia dolabriformis*, *Terminalia tomentosa* and *T. paniculata*. Mr. D. A. Thomson gives the following average diameters in his Working-Plan for the Supa Fuel Reserves, North Kanara, Bombay:—

Age	5	years: diameter	1·182 inches.
,,	10	,, ,,	2·229 ,,
,,	15	,, ,,	3·276 ,,
,,	20	,, ,,	4·438 ,,
,,	25	,, ,,	5·68 ,,
,,	30	,, ,,	6·75 ,,
,,	35	,, ,,	7·89 ,,
,,	40	,, ,,	8·947 ,,
,,	45	,, ,,	9·79 ,,
,,	50	,, ,,	10·8 ,,
,,	55	,, ,,	11·02 ,,
,,	60	,, ,,	12·04 ,,
,,	65	,, ,,	12·51 ,,
,,	70	,, ,,	13·35 ,,

In the Kanara Fuel Reserves he estimated that the average girth at 40 years was 30·72 inches, while in the Khanapur Fuel Reserves in the Belgaum district Mr. N. D. Satarawala gives the average girth at the same age as 19·68 inches only. Mr. Satarawala also gives the following figures for coppice shoots in the same forests:—

Age	4	years: girth at centre of log in inches			8
,,	6	,, ,,	,,	,,	8·3
,,	7	,, ,,	,,	,,	9·5
,,	8	,, ,,	,,	,,	10·7
,,	10	,, ,,	,,	,,	13·5
,,	12	,, ,,	,,	,,	15·3

Mr. R. S. Pearson gives the following figures showing rate of growth of "Nana" in his Working-Plans for the Kalinaddi and Ankola Forests in Kanara, Bombay :—

Age in years.	Average diameter in inches.	
	Kalinaddi.	Ankola.
10	2·9	2·7
20	5·3	4·9
30	7·5	6·7
40	9·7	8·5
50	11·9	10·3
60	14·2	11·8
70	15·9	13·3
80	17·5	14·8
90	19·0	16·2
100	20·3	17·5
110	21·7	18·8
120	22·9	18·3
130	23·9	20·6
140	25·0	21·5
150	26·1	22·6
160	26·5	23·0
170	27·6	24·2
180	28·1	24·7
190	29·0	25·6
200	31·3	25·9

In the Chedleth Range Forests, North Malabar, Madras, 20 trees gave the following results :—

Average age at	6	inches	diameter :	27·8	years.
„	„	12	„	„	49·6	„
„	„	18	„	„	71·8	„
„	„	24	„	„	103·4	„

Mr. H. Murray records the following measurements of coppice-shoots in Belgaum, Bombay :—

Age.	Height in feet.	Diameter in inches.
5	10·5	2·3
10	19	3·6
15	23	4·6
20	27·5	5·8
25	31·5	6·9
30	34·5	8·0
35	37	9·0
40	39	9·75

6. Artificial Reproduction.

In South Coimbatore a small plantation made in bamboo forest shows much the same growth as teak planted at the same time. Seedlings are apparently rather tender to transplant.

7. Notes on Distribution and Extraction in different Provinces.

(*i*) *Southern India.*

Vernacular names.—Venteak, Venteku (Tamil), Benteak, Ventek (Malayam), Bili-nandi, Benteku (Canarese).

Local distribution.—In the Madras Presidency the tree is practically confined to the eastern and southern forests adjoining Travancore, being plentiful in Malabar and occurring in fair quantities in Madura, Coimbatore and South Kanara. It is usually found in moist deciduous forests up to 4,000 feet above sea-level, but is rare on the lower levels and from some districts is reported to be common only between 2,000 and 3,000 feet. Ten feet in girth, 100 feet in height and 60 feet clear bole have been recorded in the most favourable situations.

Extraction.—Trees are selected as required by purchasers, a minimum girth being fixed which is usually about 7 feet. Felling and extracting is carried out by Government or by purchasers, by dragging, carting, floating, and sometimes in Coimbatore by means of a tram-line. In the table below are given such details as are available to help purchasers, further information being obtainable from the divisional officers. About 12,000 cubic feet can be extracted annually from South Coimbatore and 6,000 cubic feet from South Malabar.

The Malabar Timber Yards and Saw Mills Limited quote R1-15-6 per cubic foot for scantlings and R2-1-6 for planks, free on rail at Kallai.

In *Coorg* the tree is called *Nandi* (Canarese) and is found throughout the deciduous forests, reaching in favourable localities a girth of 10 feet. During the last five years about 50,000 cubic feet have been extracted, and the amount available annually in future is estimated at 16,000 cubic feet, Government royalty being paid at 3 annas per cubic foot. It is used locally in house-building.

In *Mysore* it is known as *Nandi* and is common in the Kadur and

Shimoga forests, often growing to a large size, and being extensively used for building, carts, coffee-cases and furniture. About 60,000 cubic feet may be extracted annually, the price being 12 to 15 annas per cubic foot. Sixty-six thousand cubic feet have been extracted during the last three years.

In *Travancore* the tree is called *Vevala* in Tamil and is very common in the deciduous and drier evergreen forests up to 3,000 feet. The wood is much in demand for foreign boat-building and is usually brought out in the form of large planks. About 10,000 cubic feet are sold annually, the value in the log being 10 to 12 annas per cubic foot (Bourdillon).

Figures regarding Extraction.

Division or State.	Market price.		Rate for delivery.		
	₹ a.	Per		Per	At
Central Coimbatore.	12 0	Candy of 12½ c.ft.	7 annas 8 annas (exclusive of value of timber).	Cubic foot	Palghat, Coimbatore.
South Coimbatore.	0 12	Cubic foot at forest depôts.	8 annas (exclusive of value of timber).	Do.	Podanur.
North Malabar	0 4	Cubic foot squared.	13 annas .	Do.	Calicut, Tellichery, Mysore.
South Malabar	5 0 to 15 0	Candy of 13 c.ft.	4 annas (exclusive of value of timber).	Do.	Feroke, Beypore, Calicut.
Coorg .	3½ annas	Cubic foot .	10½ annas .	Do.	Paschimavahim station, Mysore.
Mysore . .	12 to 15 annas.	Cubic foot .	14 annas .	Do.	Railway stations.

From the Coorg Working-Plans the figures given below have been taken. As however the Working-Plans have mostly expired, the figures must be taken merely as a guide to the quantity of timber the forest can produce, and up-to-date estimates should be obtained from the Deputy Conservator of Forests, Coorg.

Name of Forest.	Area in square miles.	Quantity in cubic feet available annually.
Devamachi-Mawkal . .	28	1,000
Nalkeri-Hatgat . . .	83	7,500
Anekadu-Attoor . . .	20	800
Arkeri	29	500

(*ii*) *Western India.*

Vernacular names.—Nana (Marathi and Guzrati), Nandi (Canarese).

Local distribution.—In the Bombay Presidency the home of this tree is in Kanara where it is common, occurring at all altitudes up to 2,500 feet. It prefers a well-drained slope and has some of the habits of teak, with which it is often associated. Like teak too it is found sometimes in evergreen forests, where it overtops the evergreen species. Foulkes in "Notes on Timber Trees in South Kanara" says: "*It prefers gneiss soils to laterite and does best in the low Ghat forests where the rainfall is fairly heavy,*" but in the Western Division of Kanara the finest specimens are reported to be found in dry deciduous forest on steep slopes.

In the north of the Presidency it is smaller and rarer, but is reported to occur to the extent of 5 per cent. in South Thana and 2 per cent. in Kolaba, but timber is not available.

Good trees have been seen in Kanara 10 feet in girth and 100 feet in height with a clear bole of 50 feet.

Extraction.—The size at which the tree may be felled in Kanara is usually 6 to 7 feet in girth. The forests containing the best trees are worked under the Selection system as a rule, mature trees being chosen for felling, and the trees are extracted either by purchasers or departmentally. The logs are dragged or carted from the forests, as the nature of the country allows, and are sometimes floated down to the sea-coast.

The duty charged by Government in Kanara is R3 per *khandy* of 12½ cubic feet, and the local selling price is about R8 in Eastern, R9-8 in Western, and R10 in Southern Kanara.

Details are given in the following table :—

Division.	Quantity available annually.	Rate for delivery.		
		℟	Per	At
Kanara Western Division.	530 seven-foot trees besides others from forests near Ankola.	4 to 5	Khandy .	Sea-coast.
Kanara Eastern Division.	1,500 cubic feet .	℟ a. 1 0	Cubic foot	Hubli station.
Kanara Southern Division.	.....	8 annas.	Do.	Haveri station.
		4 Do.	Do.	Honawar.

Figures from Bombay Working-Plans.

District.	Working Circle.	Area in square miles.	Mature trees on the area.	Minimum size fixed for felling.	Remarks.
Kanara	Gund, Series X and X1.	47	21,500 above 24 inches diameter.	24 inches diameter.	
Do. .	Supa, Block XX	18	48 above 24 inches diameter.	6 feet girth.	
Do .	Kalinaddi slopes, Block XXVI.	42	6,300 sound above 27 inches diameter, 400 unsound.	7 feet girth .	The annual yield is 230 trees.
Do .	Mundgod High Forest.	85	500 above 24 inches diameter.	6 feet girth.	
Do .	Ankola High Forest.	70	11,000 above 27 inches diameter.	7 feet on best locality, 6 feet elsewhere.	Annual yield 230 trees.
Do. .	Yellapur above Ghat.	137	7,000 above 24 inches diameter.	24 inches diameter.	
Do. .	Yellapur slopes .	37	11,500 above 24 inches diameter.	...	
Belgaum .	Nagargali Series	14	900 above 24 inches diameter.	24½ inches diameter.	Annual yield 38 trees.

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NOTE ON SÁNDAN

(*Ougeinia dalbergioides*, Benth.)

BY

A. RODGER, I.F.S.

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12. Anogeissus latifolia (*Bakli, Dhaura*—India).
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Sándan.

Ougeinia dalbergioides, Benth.

Natural Order—Leguminosae (Papilionaceae).

SÁNDAN.

Ougeinia dalbergioides, Benth.

Natural Order—Leguminosæ (Papilionaceæ).

1. General Distribution.

Sándan is a tree of Central India, being common in the Central Provinces and becoming less plentiful in each direction outwards from the centre, in Bengal, the United Provinces, Bombay and Madras. Its northern limit is the Dehra Dun and its southern limit, the Palni Hills in Madura.

It does not occur in Ceylon, Assam or Burma, nor in the Punjab, except perhaps to a small extent near the Jumna at the western end of the Siwaliks.

Further details are given under the various provinces.

2. Locality and Habit.

It is found much scattered in deciduous forests between a few hundred and 4,000 feet above sea-level, reaching the latter height in the Palni Hills in Southern Madras and in the Lower Himalayas, where it goes a long way up the valleys and mixes with Chir pine. It prefers fertile loams and clays, but will grow, though small and stunted, on shallow ridges. Further details are given under the various provinces.

It is a moderate-sized tree rarely attaining a girth of 7 feet and a height of 60 feet, the smaller classes being much the most numerous. The bark is thin and greyish and the trunk frequently short and irregularly shaped, but the tree, especially when in full flower, is very handsome, and is accordingly grown in gardens. It flowers between February and May about the same time as the leaves are changed, the flowers being purple, pink or white.

3. Description, Properties and Uses of Timber.

The sap-wood is narrow and grey and the heart-wood reddish or pale brown, mottled. It is hard and close-grained, durable and tough, and takes a good polish. It shows vertical bands of close-grained pale brown wood, alternating with more open tissue, on a vertical section, and the cross

section shows numerous fine concentric lines, with pores in short pale wavy bands arranged concentrically.

Durability.—The wood is not usually proof against white-ants, but has been found to last as long as 9 years in the ground without deterioration.

Weight.—The wood is fairly heavy, the mean of recorded figures being 55 lbs. From the Darjeeling *terai* a weight of 67 lbs. has been recorded (Gamble).

Strength.—The value of P, which represents the strength of a bar of timber calculated from the length between supports, breadth, and thickness of the bar, and the weight in pounds which when placed on the middle of the bar causes it to break, has been calculated at 835. This is a high figure as Sal gives 790, Teak 600 and Shisham 796 (Gamble).

Fissibility.—The wood is very difficult to split being placed by Mr. R. S. Troup at the foot of a list of 61 Indian woods tested by him, its index figure being 44·78, Teak giving 1·75, Toon 4·25, and Sal 9·33.

Calorific power.—If available in quantity for fuel it would be good, as its calorific power is high, the number of British Thermal Units recorded by Mr. Puran Singh being 8,368, Shisham giving 8,312, Teak 8,560 and Sal 8,881.

Seasoning.—In the Central Provinces the trees of this species, with others, are usually felled during the rains and the stems left unbarked leaning against others for a month or two. A paste of cowdung is also used at times and the timber is sometimes immersed in water, but it can be seasoned very well by being kept in the shade for a few months after felling, as it is not liable to split badly.

Uses.—It is in great demand for ploughs, shafts of carts and of wheels, handles of tools, bed-legs, yokes, spindles and other purposes requiring strength and toughness. The supply is not equal to the demand for these purposes and much more could be disposed of than is at present available. It has been tried at Naini Tal for casks for beer and was found to be very suitable. A small consignment was sold in London in 1878 for £3 per ton.

4. Minor Products.

When blazed the tree yields an astringent red gum and a decoction of the bark is used in Chota Nagpur when the urine is too dark coloured (H. H. Haines). The bark is pounded and used to intoxicate fish and the twigs are lopped for cattle fodder. In the Yeotmal Division of Berar lac is grown on the trees, which are soon killed by it. The fibre is

occasionally used for making ropes. During the famine of 1896-97, the flower was in great request as food in Oudh, being eaten boiled.

5. Natural Reproduction and Rate of Growth.

Seedlings are usually fairly plentiful and the tree can be readily propagated by means of root-suckers. In 1895, Mr. H. C. Hill noted in the Central Provinces that dense thickets of this and other trees were to be found wherever the beneficial influence of an old Mohwa tree was felt. Suckers produce small pure patches of young growth in many parts. In the Dehra Dun seedlings and root-shoots are plentiful where slopes and banks of nullahs let light into the dense sal forests.

Caccia records measurements taken on 90 trees in sample plots in the United Provinces over periods of years varying up to 19. The mean annual girth increment varied from *nil* to ·52 of an inch, the latter figure being exceptionally high.

6. Artificial Reproduction.

Sowings have been made in pits in Bombay with but moderate results. In the Central Provinces sowings in lines have been fairly successful, and broadcast sowings unsuccessful. The seed usually germinates easily.

7. Notes on Distribution and Extraction in different Provinces.

(*i*) *Central Provinces.*

Vernacular names.—Tinas, Tinsa, Tinnas.

Local distribution.—The tree is very widely distributed in the Central Provinces but rarely attains a large size. It grows up to 2,500 feet above sea-level scattered through the Sal, Teak and other deciduous forests, occasionally forming as much as 8 per cent. of the crop, preferring clay and deep heavy soils, and being found at times in small pure patches. In Berar it is reported to be found often on light red soils up to 3,800 feet above sea-level, on hill-tops and abandoned cultivation, and at other times on black cotton soil. In South Chanda it occasionally reaches a girth of 5 feet, with 60 feet height and 30 feet clear bole, but this is exceptional and in many districts it rarely attains a girth of 3 feet. The largest trees are found in South Chanda, Balaghat, Bilaspur, Narsingpore, Mandla, Seoni, Betul. In the last named it is held to be quite as valuable as Teak for local purposes.

Extraction.—The forests in which it grows are usually worked as Coppice with Standards, but in a few districts as High Forest, the mature trees being removed after reaching two or three feet in girth in Selection and in Improvement Fellings. The coupes are usually sold to purchasers, who remove the timber by means of carts or coolies who carry it on their heads where no cart-roads are available. From South Chanda about 100 trees over 3 feet in girth would be available annually, from Narsingpore about 5,000 cubic feet in the form of poles of varying sizes, from Mandla about 25,000 cubic feet, and from Betul 6,000 cubic feet. The royalty in South Chanda is 5 annas per cubic foot.

Figures regarding Extraction.

Forest Division.	Local market rate.				Rate for delivery.				
	₹	a.	p.	Per	₹	a.	p.	Per	At
South Chanda .	1	8	0	cubic foot in log.	0	8	6	cubic foot .	Ballarshah.
					0	6	0	Do.	Coconada.
Balaghat .	1	8	0	pair of shafts	10	0	0	hundred poles one foot in girth.	Railway stations.
	1 to 2	0 0 to 0 0	0	planed poles 26″ in girth.	35	0	0	hundred poles 1′ 6″ in girth.	
Bilaspur .	...			...	0	5	0	cubic foot .	Kargi Road station.
Narsingpore	1 to 30	0 0 to 0 0	0	hundred poles.	1	0	0	Do.	Railway stations.
Mandla . .	0	1	9	cubic foot .	1	15	0	cubic foot round.	Bombay.
					2	3	0	cubic foot converted.	Do.
					0	8	0	cubic foot round.	Railway station.
					0	12	0	cubic foot converted.	Do.
Betul . .	0	2	0	cubic foot .	0	3	3	cubic foot .	Itarsi.

(*ii*) *Rajputana and Central India Agency.*

In the *Marwar* State in Rajputana it is known as *Tinash* or *Tanach*, but is rare and does not grow to a large size. It is much in demand locally at about one rupee per cubic foot for tool handles, etc., but there is little available.

In *Gwalior* it is found, but as a small and unimportant tree.

In the State of *Rewah* it is called *Sandhan* and occurs to the extent of 3 per cent. in the Bondi and Singrouli forests, not being often found of greater girth than two feet. It is useful for agricultural implements and house-building.

In *Indore* it is found throughout the State, generally crooked and seldom attaining a great height or more than 2 feet in girth. In some of the best mixed forests, especially on the Satpuras, it attains occasionally a girth of 4 feet, but straight trees are the exception. From the more remote forests on the Khandesh borders, etc., most of the best trees have been extracted, generally illicitly. No timber is so much valued locally, and cultivators will pay any price to secure it for shafts, carts and agricultural implements. A pair of poles will sell for R8 to R10 dressed to 18″ girth 12 feet long, in the Khargone Division. In the Indore Division poles sell for R1-8 to R7. It reproduces itself profusely by root-shoots in old fields, etc., and the forests are full of young growth.

(*iii*) *Southern India.*

Vernacular names.—Bandhano (Uriya), Kallu Mokke (Tamil), Bettahonné (Canarese), Asavuni or Manimuthu (Madura).

Local distribution.—This tree is not common anywhere in Madras and does not occur in many of the districts. In Central and North Coimbatore, Ganjam and Madura it is reported to be scattered, occurring to the extent of 4 trees over 3 feet in girth per hundred acres, and reaching a girth of 4 feet and a height of 30 feet in Ganjam. In Madura the girth is sometimes as large as 6 feet, and the tree usually occurs at 3,000 to 4,000 feet above the sea, on the Palni Hills. Elsewhere it grows in mixed deciduous forests between 500 and 3,000 feet above sea-level.

Extraction.—From the hills of Madura about 500 cubic feet may be extracted annually, delivered at Kodaikanal Railway station at R1-12, and at Madura at R1-14 per cubic foot.

In *Ganjam* the wood is sold for hubs of wheels and carriage poles at 8 annas per cubic foot.

In *Hyderabad* it is known as *Tewas, Dargu, Tunuz, Talla-Modgu* or *Kodi-Mudsu* and is reported to be common at Aurangabad and in the Reserves along the Godavery. It is rarely large enough to yield a 9-inch plank, but is much used for agricultural implements and poles, being granted free to agriculturists.

In *Coorg* the tree is called *Malé Honné* and grows to a small extent in the eastern zone of the Southern forests, attaining a girth of 4 feet. It is not used locally and is not an important tree. The Government duty is 1½ annas per cubic foot.

In *Mysore* the tree is not plentiful and attains occasionally 30 feet in height and 5½ feet in girth. It is little used, but 500 cubic feet can probably be obtained annually, delivered at Railway stations at R1-4 per cubic foot. It is called *Kal-honné*.

(*iv*) *Bengal.*

Vernacular names.—Bandhan, Pandan, Ruta (Kol), Rot (Santali), Sandan (Hindi).

Local distribution.—The tree does not occur in the Kurseong, Santal Parganas, Darjeeling and Tista forests, and small trees only are found in Sambalpur, though apparently it was at one time a useful tree there. It is common in the hills of Chota Nagpur but is seldom larger than 3½ feet in girth (H. H. Haines). In Orissa it is commoner in Angul than in Puri, and trees 7 feet in girth with a total height of 50 feet and a clear bole of 25 feet are met with in the dry hill forests in open spots up to 3,000 feet above the sea. It is also found less often in the mixed sal forests of the plains.

Extraction.—In Angul the exploitable size under the Working-Plan is 4½ feet girth and in Puri 5 feet, but few sound trees above 3 feet in girth are obtainable. It is in considerable demand in Bengal for cart-wheels, selling in Cuttack and Puri at an average price of R1 per cubic foot and in Chaibassa for rather more. Trees are usually selected when required by purchasers. In Chaibassa about 100 trees per annum would probably be available and the timber can be delivered at Lota Pahar for 8 to 12 annas per cubic foot.

(v) *Western India.*

Vernacular names.—Tiwas (Marathi), Tanach (Gujarati), Karimuttal (Canarese).

Local distribution.—Only in Surat is this tree reported to be at all common, and elsewhere it is irregularly scattered as in Madras, being reported from Central and South Thana, the eastern and southern divisions of Kanara and both divisions of Khandesh. In West Kanara and Satara it is said not to occur. When found it is in deciduous forests up to 3,000 feet above sea-level, usually in open spots, rarely attaining a girth of more than 3 feet and frequently being much stunted. In the eastern division of Kanara and in Surat 5 feet trees are sometimes found with a 35 ft. bole, but the ordinary trees are much smaller. Enumerations were made for 8,600 acres in Central Thana and gave the total number of trees over 18½ inches in diameter as 172, and of trees 12 to 18½ inches in diameter as 1,545, the exploitable size for these forests being fixed at 18·5 inches.

Extraction.—Little annual outturn can be expected except from the Dangs and Mandvi forests in Surat where it pays to extract almost any kind of this timber as the worst logs fetch over ₹10 per *khandy* and good timber commands a high price. The future annual supply from these forests will be about 500 *khandies* yearly, a *khandy* being 12½ cubic feet. The cost of delivering the timber to the Tapti Valley Railway stations will be about ₹11 per *khandy*, to Bulsar ₹12 and to Surat ₹13. The local price in Kanara is ₹15 per *khandy*, and in Surat it varies from ₹16 to ₹30.

In *Baroda* it is scarce and of medium size and sells for about ₹6 for 12 cubic feet.

In the *Rajpipla* State it is fairly common in the hill forests, attaining a girth of 3 feet, and being estimated to be available in future to the extent of 4,000 cubic feet annually. 30,000 cubic feet were extracted between 1904 and 1909, the State duty being 5 annas per cubic foot and the local price about ₹1-8 per cubic foot in the round. It is extracted by Bhils and a good deal is floated down the Nerbudda. It can be delivered at Nandod or Chandod for ₹1-8 per cubic foot and at Ankleshwar for ₹1-10, the rates for converted timber being double.

Figures from Bombay Working-Plans.

District.	Working Circle.	Area in square miles.	Trees on the area.	Minimum size fixed for felling.
Kanara .	Supa, Block XX	18	6,200, 10″ to 21″ diameter. Above 21″ diameter, *nil.*	6 feet girth.
Do.	Yellapur above Ghat, Blocks XIII and XIV.	35	24,700, 1″ to 21″ diameter. Above 21″ diameter, 360.	5 feet girth.
Do.	Yellapur Slopes, Block XVII.	16	540, 1″ to 21″ diameter. Above 21″ diameter, 36.	...
Belgaum .	Nagargali Series .	14	2,800, 1″ to 21″ diameter. Above 21″ diameter, 85.	...
Thana .	Talasri . .	29	680, 18½″ diameter and over.	18 inches diameter.
			2,600, 12″—18″ diameter.	

(*vi*) *Northern India.*

Vernacular names.—Sandan, Chanjan or Panan (Oudh), Tinsa (Bundelkhand).

Local distribution.—It occurs in the Dehra Dun, outer Himalayas and Oudh forests with Sal and ascends the valleys up to 4,000 feet growing with Chir pine, preferring good soil in the valleys and becoming crooked and stunted at the higher elevations. In Pilibhit and Bundelkhand the trees are small and of little value at present. Five feet is the largest girth attained, with a height of 40 feet and a clear bole of 15 feet, but the smaller classes are much commoner, and it is quite a common tree in many parts.

Extraction.—Most of the forests in which it occurs are under the Selection system and the tree is often removed in Improvement Fellings carried out to favour Sal, a small quantity also being cut out in coupes of Coppice with Standards. No large quantity of timber is available, the most important estimate of 5,000 cubic feet per annum being supplied

from the Siwalik Division. Timber can be delivered at Railway stations from the Dehra Dun forests for about 4 annas per cubic foot roughly converted, the market price at the stations being 7 annas. In Kheri billets 3 feet long and 3 feet in girth are sold at the Railway line for 12 annas or one rupee each for bed-legs, delivery at the Railway station from the forest costing 8 annas each. In Gorakhpur delivery to Railway stations costs 8 to 13 annas per cubic foot, the market rate of the same being 8 to 10 annas.

In *Jammu* and *Kashmir* it is called *Sanunan* and is found in the lower ranges of hills below 300 feet. It rarely attains a girth of more than 2 feet and is much lopped and browsed but not much used otherwise.

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NOTE ON DHAURA OR BAKLI

(*Anogeissus latifolia*, Wall.)

BY

A. RODGER, I.F.S.

CALCUTTA
SUPERINTENDENT GOVERNMENT PRINTING, INDIA
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Dhaura or Bakli.

Anogeissus latifolia, Wall.

Natural Order—Combretaceae.

DHAURA OR BAKLI.

Anogeissus latifolia, Wall.

Natural Order—Combretaceæ.

1. General Distribution.

This tree occurs principally in Central and Southern India, and is absent in Burma and Eastern Bengal and Assam. It is most numerous between 76° and 84° longitude running from Dehra Dun in the north through the Central Provinces to Tinnevelly and Ceylon in the south, and extends through Chota Nagpur and the northern part of Madras. In Bombay it is not so plentiful on the whole, and in Sindh it is absent, but a few trees grow in Ajmer-Merwara. Further details are given under each province.

In Ceylon it is found on open grass lands in the dry country, and is plentiful in certain localities, but not on the whole. It is called *Dawu*.

2. Locality and Habit.

This species is able to grow at all altitudes between 200 and 4,000 feet and attains its largest size in deep loams at the foot of hills as in Ganjam and Madura, Madras, where specimens 10 feet in girth occur. It is more commonly found on slopes between 1,500 and 2,500 feet where it grows on laterite and granite soil, not demanding much from them and standing exposure, though remaining much smaller than at the lower levels. On such localities it forms at times as much as 50 per cent. of the crop. In the Central Provinces it is also found on deep trap soil.

Its companions are usually Sal, *Terminalia tomentosa*, *Butea frondosa*, *Diospyros Melanoxylon* and similar trees, and occasionally Teak. It is a tall straight tree with smooth mottled bark and numerous moderate-sized leaves which become red or brown in November and December and fall in February, the new leaves appearing in May and the flowers during the rains. A variety called *Anogeissus tomentosa* is reported by H. H. Haines from parts of Chota Nagpur.

3. Description, Properties and Uses of Timber.

The wood is grey or yellowish in colour with numerous very small pores, and close-grained. It shows handsome shining horizontal bands on a vertical section and is sometimes cross-grained. The heart-wood is small, irregular, hard, and purplish in colour. It often contains small knots and flaws and is accordingly unsuitable for such purposes as the manufacture of fishing rods.

Durability.—It is not durable unless kept dry and is very apt to split when seasoning. It has been tried for sleepers but large trees are not plentiful enough to make it very useful for this purpose. Eighteen sleepers were tried on the Mysore State Railway and 14 of them were found to be serviceable after 7 or 8 years. It is often attacked by white-ants so that it must be treated with antiseptics when it is wanted for house posts, etc. Some rafters used in a bungalow at Surada in northern Madras are quite good after 20 years' use. The wood was found when tested in Madras to have little power of resistance to the attacks of the *teredo*, and it proved unsuitable for sleepers on the South Indian Railway in 1899.

Weight.—The weight given in Gamble's "Manual of Indian Timbers" is 62 lbs. per cubic foot dry, and 75 to 80 lbs. when green. This is calculated from specimens collected all over India.

Strength.—The value of P, which represents the strength of a bar of timber calculated from the length between supports, breadth and thickness of the bar, and the weight in lbs. which when placed on the middle of the bar causes it to break, is for this timber about 900, the figures for Sal being 790, Teak 600 and Shisham 796 (Gamble). Very varying results have been recorded, one being as high as 1,220, but 850 to 900 is probably correct, this high figure accounting for the toughness and consequent great usefulness of the wood.

Fissibility.—The wood is not very easy to split, experiments made by Mr. R. S. Troup giving the figure 6·33, the corresponding figure for Teak being 1·75, for *Acacia Catechu* 2·98, and for *Terminalia tomentosa* 4·63.

Calorific power.—The wood has been tested by Mr. Puran Singh, Forest Chemist, and his results placed it rather low on the list, beside Bael, and a long way below Sal, Teak, and Blue and Chir pines. The number of British Thermal Units is given for the last-named as 9144, and for *dhaura* as 7481. It is commonly however used as fuel and gives good charcoal.

Seasoning.—In the Central Provinces the people usually prefer to cut

it during the rains, as in the case of Sain, and it is often left unbarked in the forest to season during the rains, or put into water for a month or two. It is also sometimes barked and plastered with cow-dung, and in parts of Bombay it is steeped in salt water after felling. It must be seasoned very slowly as it is very apt to split and warp.

Uses.—It is a favourite wood for shafts and especially axles of carts, plough and tool handles and yokes, and is also used by the poorer class of cultivators for building. In Madras it is used in the Kolar Gold Mines, and in Orissa for sugar-cane presses. It is very largely used for fuel, being sold in Bombay for ₹4 to ₹6 per *khandy* of 784 lbs. and is a very popular wood for charcoal. It polishes well, without absorbing much polish.

4. Minor Products.

The most important minor product is the gum which is collected in many parts of India and sold at from one to two annas per lb. It is used for native sweatmeats, as an adhesive in cloth printing and by the Santhals in Chota Nagpur for cholera. The gum is reported from northern Madras to exude in appreciable quantities only once in 5 years, not every year, and not to be obtainable from the largest trees. It forms the bulk of the *Gum Ghati* sold in Bombay, the prices at the beginning of 1912 being as follows :—

	₹	₹	
Uncleaned . . .	10 to	18	per cwt. according to quality.
Cleaned . . .	18 „	25	do. do.

The leaves are largely used for tanning, the skin usually being made into a bag and the leaves placed inside with water. The leaves have been found to contain 15·5 per cent. of tannic acid. A number of liquid extracts were roughly prepared in the forest and analysed by Mr. D. Hooper, Curator of the Economic Section, Indian Museum, in 1898 and 1899. The extracts prepared from the bark and leaves from the Central Provinces gave the following results :—

Part used.	Percentage of dry extract.	Percentage of tannin.	Percentage of tannin in the dry extract.
Bark	6·0	3·08	51·3
Leaves	34·2	10·0	34·4

The methods of tanning principally employed in Damoh, Central Provinces, are as follows :—

Method of tanning with ghaunt (*Zizyphus xylopyra*) *and dhaura leaves.*—The first liquor or *kas* is prepared from 5 to 6 seers of *ghaunt*, which has been dried and powdered, mixed with 20 seers of clean cold water in a *nand* (wide-mouthed jar). This is left standing for about one hour, when the colour of the *ghaunt* diffuses into the water. The hide remains in this liquor for 3 days, it being taken out twice to thrice every day and rubbed with the hand for about one hour. At the end of the third day the hide is taken out of the *nand*, rubbed, wrung out, and spread to dry for about 3 hours.

The second *kas* or liquor is prepared from 7½ to 8 seers of *ghaunt* mixed with 20 seers of clean water, in which the hide remains for four days, it being taken out, rubbed and worked three times daily. After 4 days it is taken out, wrung out and dried as before and is then put into the third *kas*. This consists of 6 to 7 seers of *dhaura* leaves mixed with 20 seers of water and the hide remains in this for 2 days, being rubbed daily as before and on the third day it is wrung out and dried. Some *Chamárs* mix *dhaura* leaves with the *ghaunt* in the second *kas*, the proportions being 3 seers of *dhaura* leaves or *kaspatti*, 3 seers of *ghaunt* and 20 seers of clean water. In this case a third *kas* is not always necessary. A piece is cut from the edge of the hide to see if the colour has passed right through the skin, and if it is found that the hide is whitish in the interior, it is considered to be insufficiently tanned and a third *kas* is accordingly given, it being a repetition of the second.

Other *Chamárs* again mix no *ghaunt* in the second *kas* which consists of 5 to 6 seers of *dhaura* leaves or *kaspatti*, and 20 seers of water ; and in this case no third *kas* is given.

In all cases, however, after treatment with the *kas* (or liquor) as described, the hide is sewn up like a bag with the bark of *kulu* (*Sterculia urens*) root of *chheola* (*Butea frondosa*) or leaves of *khajuri* (*Phœnix sylvestris* and *P. acaulis*), leaving an aperture of about a span's width at one end. It is then hung up on a pole, the opening being uppermost, and is filled half with *dhaura* leaves and half with water. The quantity of leaves used depends on the size of the skin and kind of leaves used. About 4 or 5 seers are necessary for a goat's skin and from 16 to 17 seers for half a hide of a buffalo or cow. Also if the leaves are young, more is used than is the case if the leaves are old. A *nand* is placed

below the hide so that the solution which filters through the skin is collected in it. The contents of this *nand* are poured back into the hide 4 times during the day and 4 times during the night. This continues for 2 days, when the aperture is sown up, the bag reversed and an opening made in the bottom of the bag, which is now uppermost, and the process continues as before for one day and a night, the object of this being to get both the upper and lower portions of the skin thoroughly impregnated with the solution. The hide is then taken down, opened, washed in clean water and dried. It is then rubbed well for about half an hour, with ½ seer of salt mixed with one seer of curds, when it is left to dry and the operation is complete. The leather produced by this method is of a yellow colour.

Method of tanning with dhaura leaves alone.—The process is much the same as described above in the *ghaunt-dhaura* method. The first *kas* in this case consists of about 6 seers of *dhaura* leaves and the second and third of 8 seers, the quantity of water used being the same in each, *i.e.*, about 20 seers. The hide remains in the first *kas* for 3 days, in the second 4 days and in the third 2 days. After treatment with the *kas* the hide is hung up and filled half full with *dhaura* leaves and half with water and is treated just as described above. The leather produced by this method is of a greenish yellow colour and is very liable to crack. To prevent this the leather is rubbed with the *tilli* oil.

Method of tanning with dhaura leaves and harra (myrabolans).—This is exactly the same as the last with the exception that half the quantity of *dhaura* leaves is used mixed with an equal quantity of *harra*. The leather produced is of a brighter yellow than the last, but is also liable to crack.

[*Tanning materials used in the Damoh District, Central Provinces*, by R. S. Hole—*Indian Forester*, July 1899.]

The *tasar* silk-worm is sometimes fed on the leaves.

The white wax insect (*Ceroplastes ceriferus*) has been reputed as found on this tree.

It has been noted by M. Rama Rao to be an associate of Sandal but root attachments between the two have not been found.

5. Natural Reproduction and Rate of Growth.

Natural reproduction is reported to be fairly plentiful in most forests. Heavy grazing and fire do much to keep it back, but it responds to

fire-protection as may be seen on the slopes of the Siwaliks, the outer Himalayan slopes and similar localities in Central and Southern India (Gamble).

The tree usually coppices readily. Mr. R. S. Pearson wrote a detailed reported in the *Indian Forester* for May 1907 on a good crop found in the Panch Mahals in Bombay. He decides that well-drained situations and good light are necessary, and records his opinion that the tree, though producing seed yearly, rarely produces great quantities of fertile seed except under special conditions which depend on the temperature and rainfall of the year. Mr. A. K. Desai, Ranger, Godra Range, Panch Mahals, notes that *dhaura* seedlings were found in great abundance in his forests after the dead timber killed by the drought of 1899-1900 had been removed. A great opening out took place, the seeds accumulated in the soil during the drought, and the young plants filled up many of the blanks when the rain came.

Bourdillon and Gamble say the rate of growth is moderate, about 7 rings per inch of radius.

Caccia gives measurements taken on 52 trees in sample plots in the United Provinces, some of which extended over 17 years, which indicate that the mean annual girth increment varies from ·14 to ·63 of an inch.

From countings made in the Nallamalai Forests, Kurnool, Madras, the average number of rings to an inch of diameter was found to be 7.

6. Artificial Reproduction.

Sowing and planting have been tried in Bombay, the former when done in patches giving the best results. Broadcast sowing is more uncertain, but dibbling has given a fair number of seedlings, about 20 per cent. of the seed producing plants. Mr. H. H. Haines states that the fruits should not be gathered until they begin to separate from the heads. The seed requires a perfectly clean soil for germination and is excessively impatient of weeds or water-logging. The best results were obtained on mounds of gravel. Broadcast sowing has been tried in a number of forest divisions, almost always without success.

7. Notes on Distribution and Extraction in different Provinces.

(*i*) *Central Provinces.*

Vernacular names.—Dhamora, Dhaura, Dhawa.

Local distribution.—Over the greater part of the Central Provinces the tree is not very plentiful, but in the west it occurs to a larger extent than elsewhere, being reported from Raipur to form sometimes 20 per cent. and from Jubbulpur 15 per cent. of the whole crop. It grows best on low-lying land up to 1,500 feet but occurs up to 2,500 feet in smaller sizes. Very exposed dry slopes do not suit it but it thrives on the lower slopes on north and west aspects in mixed deciduous forests. On plateaux and high slopes it is dwarfed, much branched and early becomes hollow. In South Chanda girths of 6 feet are recorded with a total height of 90 feet and a clear bole of 60 feet, but two or three feet is a much more common girth measurement, with 40 feet height and in some divisions 25 feet is more usual. In Berar the tree produces chiefly fuel being felled in Coppice with Standards and sometimes pollarded. In parts of Nimar it produces timber. In 1892 and 1897 the tree suffered greatly in the Damoh forests from the ravages of a small caterpillar which devoured the whole leaf. New leaves were produced in July (R. C. Thompson).

Extraction.—The forests containing the tree are almost everywhere worked under the system of Coppice with Standards so that large timber is not available as a rule, except in the more remote forests of a few districts. Extraction is done almost entirely by carting by the purchasers of the annual coupes, who undertake the whole of the work in most cases. Government has to cut back the unmarketable stems left on the ground. The coppice is largely used for fuel, but the larger stems are very useful in cart-building. When some of the inaccessible forests are opened up by roads, a large quantity of this timber will be available and will be in good demand on account of its strength and toughness. In the following

table figures are given for each district from which timber may become available :—

Forest Division.	Local market Rate.		Government Royalty.		Rate for delivery.		
	R a. p.	Per	R a. p.	Per	R a. p.	Per	At
Saugor . .	0 0 6 to 0 6 0	pole	0 2 0	c.ft.	2 to 6 annas	c.ft.	Railway stations.
					1 0 0	c.ft.	Bombay.
					0 6 6	c ft.	Cawnpore. Agra.
Mandla . .	0 1 9	c.ft.	0 0 9	c.ft.	1 15 0	c.ft. round	Bombay.
					2 3 0	c.ft. converted	Bombay.
					0 8 0	c.ft. round	Railway stations.
					0 12 0	c.ft. converted	Railway stations.
Raipur . .	4 0 0 to 34 0 0	hundred poles.	2 annas	c.ft.	0 5 0	c.ft.	Dhamtri and Rajin.
					0 7 0	,,	Raipur.
South Chanda	...	...	2 annas	c.ft.	0 7 6	c.ft.	Ballarshah.
					0 5 6	in rough	Rajahmandri, Cocanada.
					0 4 0	squares	
Damoh . .	3 to 20	hundred poles.	2 annas	c.ft.	0 2 0	c.ft.	Railway stations.
					0 13 0	,,	Bombay.
					0 5 0	,,	Jubbulpore.

(ii) Central India.

In *Gwalior* the tree is common, being called *Dhakri* or *Safed Dhau*, and frequently occurs as underwood in *Boswellia* forests. It does not often exceed 3 feet in girth but is extracted for shafts, poles, etc. The royalty is R2 per cart-load or one anna six pies per cubic foot.

In the State of *Rewah* the tree forms about 2 per cent. of the forest

growth in most parts, but does not grow larger than 2 feet in girth. It is a useful fuel and is used for axe-handles, etc.

In *Indore* it is widely distributed but seldom grows tall and straight or attains any great girth, except in the Satpuras and in the south-west of Nimawar where it grows to 4 or 5 feet in girth. It is usually crooked and stunted, but is much in demand as poles for agricultural implements and tool handles, and as fuel and charcoal. The leaves are used for tanning and the gum is collected for sale. It is called *Dhaura*.

(*iii*) *Western India.*

Vernacular names.—Dhauda, Dindal, Dindiga, Dhavada, Dhaura, Dhamodo (Gujrati).

Local distribution.—This species is fairly common in the northern forests of Bombay being reported to form about 10 per cent. of the crop in parts of South Thana, and a considerable proportion in Nasik, Khandesh, and the Panch Mahals. In the southern forests it is very local being abundant for example in the Eastern Division of Kanara and almost absent in the Western and Southern Divisions. It is found in deciduous forest and ascends as high as 2,000 feet, preferring the higher slopes as a rule and disliking flat lands and black soils. A tree of five feet in girth with a height of 50 to 60 feet, is considered large, the majority of trees growing rather crooked with short poles, and being felled at 3 feet in girth or less. Large trees are frequently hollow.

Extraction.—Trees are felled under the system of Coppice with Standards in most divisions and the coupes sold standing to purchasers who remove the timber or fuel in carts, but almost the whole outturn seems to be converted into fuel so that figures for delivering timber will not be of value. The fuel sells easily in Bombay for ₹4 to ₹6 per *khandy* of 784 lbs., and the charcoal sells for ₹15 per *khandy*. The cost of delivering 50 cubic feet of poles at Hubli in Kanara from the forest is ₹40. In Surat axles sell in the towns for ₹1 to ₹1-8 each, and are in good demand, the duty in the forests being 3 annas per axle, no tree below 18 inches in girth at breast-height being felled, and the trees yielding one to three axles each.

In *Baroda* it was formerly abundant but little is now available. Cart-axles sell for one anna six pies each.

(*iv*) *Southern India.*

Vernacular names.—*Tamil.*—Nawai, Velnagai, Vekkali.

Telugu.—Chirimawe, Chirimamidi, Chirumanu, Chiriman, Yelama, Elama.

Canarese.—Bejjal, Dinduga, Dindal, Dindu.

Malaiyalam.—Vella-naga.

Uriya.—Dhau.

Local distribution.—The Madras Presidency appears to be the most important home of this tree, only a few districts, among which are Guntur, Anantapur, and South Kanara, reporting it to be scarce. It is pre-eminently a tree of south-eastern India, being abundant in Madura, and in Tinnevelly, where it forms as much as fifty per cent. of the forest growth on the dry upper slopes. It is not exacting as regards elevation being found at from 200 feet to 4,000 feet. It is reported at the latter altitude in the southern portion of the Presidency. It descends lower on the East than on the West Coast.

Dry deciduous forests are usually its home, and it can grow in poor soil and on exposed slopes, on laterite and on granite soil, though its largest dimensions are attained in the deep loams at the foot of the hills, as in Ganjam, where trees 6 feet in girth, 70 feet in height with a 40 feet bole are found, but the tree is considered as "inauspicious," and is not used for building. In most of the favourable localities the girth is 3 to 5 feet, but small stunted trees, coppice shoots, or poles are the commonest in Nellore, Kistna, West Kurnool, Cuddapah, Trichinopoly, Coimbatore, Tinnevelly, Bellary, South Salem and Guntur. From Madura trees 10 feet in girth and 60 feet high are reported and 8½ feet girth is recorded from South Salem.

Mr. A. W. Lushington notes that the tree forms large patches all over the hills of North Coimbatore except in the parts which contain *Acacia Sundra*. It grows to 6 feet in girth, but is usually met with as a pole.

In few localities is it sound, the constant fires having made it knotty externally and full of heart-shakes and dry rot internally.

Extraction.—Where fuel is much in demand in Madras the forests are usually worked as Coppice with Standards. In the more remote hill timber forests the tree is selected as required by purchasers who drag the logs to the nearest cart-road. From most of the forests little timber will be available for some time to come and figures are given below for those divisions which will be able to provide it.

In *Coorg* the tree is called *Dindiga* and is found extensively in the eastern forests, attaining a girth of six feet in favourable localities. It is not used locally but is exported for use as props in the Kolar Gold Mines. The Government royalty is 2½ annas per cubic foot, and about 10,000 cubic feet will be available annually, 30,000 cubic feet having been extracted during the last three years.

In *Hyderabad* the tree is called *Dhaura, Tiruman, Dhamora, Sirriwal, Dhounda, Sirward, Gondi* and is one of the most useful trees of the State. Good poles sell readily for R2 each, and are used very largely for cart axles and ploughs. Smaller poles are much used as props in sugar-cane plantations. Near Hyderabad city it is made into charcoal. It is generally distributed but does not attain any size in the southern or western divisions. In the Telingana forests near the Godavery it sometimes attains a girth of 4 feet but it is seldom that a sound log of more than twelve inches in diameter is obtained. About 500,000 poles have been and can be extracted annually from the Warangal, Karimnagar and Adilabad forests.

In *Mysore* it is called *Dindiga* and is common and often gregarious in the forests of the Mysore, Kadur and Shimoga districts. It is used for axe-handles, axles, furniture, etc., and in the Kolar Gold Mines. About 75,000 cubic feet may be extracted annually. During the last three years 192,000 cubic feet have been extracted.

In *Travancore* the tree is called *Vekkali* or *Maru Kanchiram* and is very abundant in parts of the southern portion of the State, on the Cardamon Hills, and elsewhere in the drier deciduous forests up to 4,000 feet, always avoiding the wetter parts of the country. It attains a diameter of two feet, yielding axe-handles, poles, etc., and is much cut for fuel and charcoal in South Travancore where it rarely attains a large size on the dry slopes (Bourdillon).

In the following table are given the figures available :—

Division or State.	Local prices.		Rate for delivery.		
	ℛ a. p.	Per	ℛ a. p.	Per	At
Madura . .	0 8 0	c.ft. squared.	1 10 0	c.ft.	Ammayanaicka-noor.
Vizagapatam .	0 12 0	c.ft. round.	0 15 0	c.ft.	Narasapatam Road.
	1 2 0	c.ft. squared.	1 2 0	c.ft.	Vizagapatam.
South Coimba-tore.	..	..	0 8 0	c.ft.	Podanur.
North Malabar .	0 10 0	c.ft. at Kolar.	0 11 0	c.ft.	Nangangode.
Coorg . .	0 4 6	c.ft.	0 11 6	c.ft.	Paschimavahini station, Mysore.
Mysore . .	10 to 12 annas	c.ft.	12 annas	c.ft.	Railway stations.

Figures from Madras Working-Plans.

District.	Working Circle.	Area in square miles.	Number of trees.						
			Diameter in inches.						
			1″—6″	6″—12″	12″—18″	18″—24″	24″—30″	30″—36″	Over 36″
Coimbatore .	Punachi, Anamalai Hills.	4	44,000	19,500	14,000	5,000	900	140	22
South Coimbatore.	Thalingi .	8	59,000	22,000	5,000	400	9	...	...

(v) *Punjab.*

Vernacular names.—Dhau, Chhál.

Local distribution.—This tree is abundant in the Kangra and Simla Hills Divisions but is not reported from any other. It grows between

1,500 and 3,000 feet above sea-level in mixed forests and forms sometimes 50 per cent. of the crop, and is as plentiful in places as 10 trees to the acre. It is however nearly always stunted, with girth rarely exceeding three feet and trunk often hollow, so that it is of little commercial importance, but yields a certain amount of small timber for local villagers' use, the rate they pay being 8 annas per tree.

In the *Marwar State* it is called *Goria Dhau* or *Golia Dhao* and is found throughout the higher zone of the Aravali Hills at 2,000 to 3,000 feet, where it is one of the most important species and grows with *Boswellia serrata* and *Odina Wodier*, and sometimes pure on plateaux and gentle slopes. Towards the north it occurs to a less extent. It is much used by the villagers for agricultural implements, tool-handles, etc. The Government royalty is about 7 annas per cubic foot and the market rate about 14 annas. Timber is not available for export.

In *Ajmer-Merwara* it is called *Golia dhau* and is found in small numbers in the Todgarh forest where it reaches a height of 15 feet and is extracted for fuel.

In *Bikaner* a few trees have been grown in the State garden.

(*vi*) *United Provinces.*

Vernacular names.—Bakli, Dhau, Dhura, Dhon, Dho.

Local distribution.—*Dhau* is very local in the United Provinces, being absent from Pilibhit and Kheri, and fairly plentiful in the submontane tracts and plain forests elsewhere. It grows in the mixed deciduous forests and at times as an associate of Sal, where it has like other trees suffered in operations carried out in order to favour the more valuable species. Sound trees up to 6 feet in girth are not uncommon, and logs 40 feet in length and 4 feet in girth can usually be obtained. In Bundelkhand the trees are usually smaller. Small trees are found in great numbers on the lower slopes of the Himalayas near Dehra Dun, forming at times a pure forest, but these do not grow to a large size. Mr. T. Carr reports a tree in the Sarda Range, Haldwani Division, measuring 9′ 3″ at breast-height and quite sound, with a straight bole 24 feet long.

Extraction.—Most of the trees felled come out in Improvement fellings or are specially selected for traders in the most accessible parts of

the forests. In Gonda the tree is considered mature on attaining a girth of six feet. Logs are exported in the round as it is difficult to saw by hand, the coupes being sold to contractors, as usual in these Provinces.

The following table gives the available details :—

Division.	Royalty.		Rate for delivery.		
	₹ a. p.	Per	₹	Per	At
Haldwani . .	...	...	3 to 5 annas.	c. ft.	Haldwani or Lalkua.
Bahraich . .	0 2 0	c. ft.	7 annas.	do.	Bahraich.
Gonda . .	0 3 0	c.ft. round.	5 annas.	do.	Railway stations.
	0 4 0	c.ft. rough squared.			
Siwaliks (Dehra Dun).	...	...	6 annas.	do.	Railway stations.

(*vii*) *Bengal.*

Vernacular names.—Dhoura, Hesel (Santal Parganas), Dhau, Dhaunta, Saia.

Local distribution.—The tree is fairly common in all the forests of Bengal and Orissa except in Kurseong, Tista and Darjeeling in the north where it is not found. It favours the drier hills forming a large proportion of the growing stock in Chota Nagpur, and ascending as high as 3,000 feet growing usually with Sal, Terminalias and other deciduous trees. In Orissa trees 7 feet in girth are occasionally found, but further north the limit is usually 5 feet and the commonest size 3 to 4 feet. Its greatest height is 60 feet with a clear bole of 40 feet.

Extraction.—In Sambalpur, Santal Parganas and Puri Coppice fellings are carried out and elsewhere trees are selected as required, a

limit of girth usually being observed. Purchasers buy the marked trees and extract them usually with carts, occasionally also by dragging and floating, slung to boats, as in Orissa.

The following table shows the figures available :—

Division.	Royalty.		Market value.		Rate for delivery.		
	₹	Per	₹ a. p.	Per	₹ a. p.	Per	At
Angul . .	1 to 3 annas. 9 pies to 2 annas.	c. ft. green. c. ft. dry.	0 4 0	c. ft.	0 6 0	c. ft.	Cuttack.
Chaibassa .	...	...	...	...	0 10 0	c. ft.	Lotapahar.
Puri . .	1 anna	c. ft.	0 5 0	c. ft.	0 4 0 0 6 0	c. ft. c. ft.	Balugam. Cuttack.
Sambalpur .	2 annas	c. ft. green.	.	...	0 10 0	c. ft.	Railway stations.
	1 anna	c. ft. dry.	...	..	1 10 0	c. ft.	Calcutta.

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A Note on the Causes and Effects of the Drought of 1907 & 1908 on the *Sál* Forests of the United Provinces

BY

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Photo.-Mechl. Dept., Thomason College, Roorkee.

EXTENSIVE DAMAGE BY DROUGHT IN THE CIS-SARDA FORESTS, KHERI DIVISION, U. P.

[Frontispiece.

A Note on the Causes and Effects of the Drought of 1907 & 1908 on the *Sál* Forests of the United Provinces.

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1. Introductory.

THE partial failure of the monsoon rains of 1907 and 1908 had a disastrous effect on the *Sál* forests of the United Provinces, chiefly in Oudh, resulting as it did in the most severe drought within the memory of man, and causing the death of hundreds of thousands of valuable trees. This note, which deals with the ascertained causes and effects of the drought, has been compiled partly as a result of personal visits to the affected areas during the past three years, and partly from information kindly supplied by Forest Officers in the localities concerned. Special acknowledgments are due to Mr. P. H. Clutterbuck, Conservator of Forests, and Mr. F. Canning, Deputy Conservator of Forests, for notes and suggestions.

2. Tracts affected, and Extent of Damage.

General extent of damage.

The tracts mainly affected were the *Sál* forests of the Gorakhpur, Gonda, Bahraich, Kheri and Pilibhit Forest Divisions, the plains (*tarai*) *Sál* forests of the Haldwani Division and, to a lesser extent, the *tarai Sál* forests of the Ramnagar Division. It is noteworthy that the damage done in the outer hills was trifling compared with that in the plains forests: the probable reason of this is given in Section 8 below.

The following notes describe briefly the extent of damage in each Forest Division :—

Gorakhpur.

About 8,000 acres are estimated to have been seriously affected, and 6,000 acres to have been affected in a lesser degree. On an area of 2,800 acres no fewer than 17,240 completely dead trees were marked for sale in June 1909, while after the extraction of these 15,700 more dead or dying trees were marked over the same area in June 1910, owing to subsequent casualties.

Gonda.

Extensive damage was done in the Tikri forest (plains). In the Tulsipur forests (sub-montane) the effects were not so marked.

Bahraich.

In the Motipur forests probably at least $\frac{1}{3}$ of the growing stock has been destroyed. In the coupe marked in 1909-10 (area 964 acres) only 810 I class * green *Sál* trees were found available for extraction as compared with 2,650 prescribed in the working-plan, while 4,869 dead II * and III * class trees were marked. The Chakia forest also suffered severely.

Kheri.

Cis-Sarda forests.—These forests, which are drier and poorer in quality than those of the trans-Sarda tract, probably suffered more than any other forests in the drought-affected region, there being extensive areas over which every tree, except a few individuals of specially hardy species, was killed outright. The extent of damage in such cases may be gauged from the photographs in Plate I. By June 1909 it was estimated that the stock on 10,000 acres was quite dead while that on 55,000 acres was very seriously affected.

Trans-Sarda forests.—In these forests, which are moister and of better quality than the cis-Sarda forests, the damage, though considerable, was not so extensive as in the latter, the trees dying sporadically or in small groups rather than in large patches. In 1910, countings of dead trees over an area of 9,000 acres showed a death rate of slightly over three trees per acre for the past two years : the mortality was greatest

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* I class = 6′ in girth and over.
II ,, = 4½′-6′ in girth.
III ,, = 3′-4½′ ,,

in the case of III class trees, of which nearly 10 per cent. died. In the markings for selection fellings in the same year it was found that over 9 per cent. of the II class trees and over 8 per cent. of the III class trees were dead.

Pilibhit.

The Pilibhit forests, which to some extent resemble the Kheri cis-Sarda forests, were badly affected, the damage being severe over about 5,450 acres, where the trees were killed in patches and strips of varying extent. Elsewhere they died sporadically or in small groups.

Haldwani.

The damage done in the Haldwani Division was comparatively small except in the Horai forests, which are situated on *tarai* land in the plains. Severe damage occurred over 4,000 acres and slight damage over 2,000 acres. In the outer hills trees died sporadically, but on the whole the damage was slight.

Ramnagar.

This Division may be taken to be the western limit of the drought-affected area. Sporadic dying of trees, chiefly *Sál*, occurred to some extent in the hilly tracts. In the plains (*tarai*) forests of the Jaspur Range trees have been observed to die off here and there for some years past, but there is nothing to connect this invariably with drought: in some cases it is attributable to a considerable extent to frost.

3. Origin of Damage by Drought.

All facts point to the direct cause of the damage being due to the abnormal failure of the monsoon rains of 1907 and 1908,* resulting in (1) the lowering of the subsoil water-level, (2) the dessication of the soil above that level.

Diminished rainfall.

The table on the reverse gives the annual rainfall figures from 1901 to 1910 in the five districts in which the damage by drought was most severe.

* An exception in the case of Pilibhit Division is noted below.

Average rainfall figures 1901 to 1910.

District.	1901.	1902.	1903.	1904.	1905.	1906.	1907.	1908.	1909.	1910.	Average for eight years 1901 to 1910, excluding 1907 and 1908.	Remarks.
							(Years of deficient rainfall.)					
Gorakhpur .	42·14	41·30	64·30	54·59	50·08	51·29	28·10	36·77	52·68	65·17	52·69	7 stations.
Gonda .	36·17	44·08	66·16	47·68	50·09	51·91	18·09	27·04	44·47	55·81	49·55	3 „
Bahraich .	39·82	41·65	56·96	43·92	39·11	41·66	18·38	26·94	48·35	47·13	44·82	3 stations in 1907, 1908, 1909 and 1910. 4 stations prior to 1907.
Kheri .	42·07	31·33	42·32	39·59	33·38	39·73	19·76	27·16	47·25	47·76	40·43	3 stations.
Pilibhit .	52·28	46·38	53·33	43·38	27·47	40·21	31·68	45·29	59·50	55·21	47·22	5 „

It will be seen that in all the Districts except Pilibhit the deficiency was most marked in the years 1907 and 1908. Pilibhit shows considerable deficiency in 1907, but practically none in 1908: notwithstanding this the damage by drought in this District was severe. This result, however, may well have been produced by the abnormal deficiency in 1905 followed two years later by that of 1907, with a none too copious rainfall in the intervening year.

Lowering of subsoil water-level: Kheri Division.

In the Kheri Division the following average figures, furnished by Mr. F. Canning, the Divisional Forest Officer, from measurements in 20 wells in the cis-Sarda and 55 wells in the trans-Sarda forests, show the extent to which the subterranean water-level had sunk as compared with previous measurements made in 1894 :—

Month and Year.	Average depth of water from ground level.	
	Cis-Sarda.	*Trans-Sarda.*
1894	11′ 1″	13′
January, 1908	20′ 6″	..
July „	21′ 2″	..
November „	21′ 2″	..
December „	..	18′
March 1909	21′ 9″	20′
December „	17′ 4″	16′

These figures show an average maximum fall of 10 ft. in the cis-Sarda and 7 ft. in the trans-Sarda forests as compared with the 1894 measurements. The maximum fall registered in the cis-Sarda forests is one of 26 ft. The subsequent rise by the end of 1909, after a year of ample rainfall, is noticeable.

Bahraich Division.

In the Bahraich Division measurements were taken in the end of 1908 in 43 wells and compared with measurements made in the same wells in May and June 1906. Four wells showed a rise averaging 4′ 9″. All these were in an area where the damage was very slight, and it is possible that the difference in the time of year at which the respective measurements were made may have accounted to some extent for the rise. All the remaining wells showed a fall. The following statement, compiled by Mr. J. C. Tulloch, the Divisional Forest Officer, from these measurements and from

the records of dead trees marked in the various coupes in 1908-09, furnishes some interesting information :—

Working Circle.	Compartment.	Area (acres).	Percentage of trees which have died.	Fall in spring water-level.
I	1 to 6b . .	12,323	4½	1′ 9″
I	7a to 10c . .	7,728	7	2′ 0″
I	11a to 12b . .	3,488	12	2′ 0″
I	14a to 22 . .	11,572	8	1′ 11″
I	23a to 26b . .	6,190	3	0′ 11″
II	Area open to grazing—no records kept.			
III	Whole area . .	6,958	13	10′ 10″
IV	,, . .	3,093	3	2′ 8″
V	,, .	5,574	3	2′ 8″
VI	,, . .	38,371	1	2′ 5″
VII	,, . .	17,955	2	4′ 10″
VIII	,, . .	13,475	2	4′ 10″

It will be seen that in Working Circle I the mortality varies more or less according to the fall of the water-level. Working Circles VII and VIII are situated on the lower slopes of the hills in the Sub-Himalayan tract, and statistics in the case of these cannot be accurately compared with those of the other working circles, which are situated in the plains.

Gonda Division.

In the Tikri forest of the Gonda Division, the water-level sank about 8 ft. as compared with measurements made in 1896.

4. General Description of the Drought and its Effects.

Early symptoms and subsequent action of drought.

The first indication of any abnormal state in the forests affected was the somewhat scanty foliage put on by the *Sál* trees in 1908, as a result of the failure of the rains in 1907. Had 1908 been a year of normal rainfall possibly nothing further would have happened, or probably at most the damage would in the majority of cases have been slight. The failure of the rains

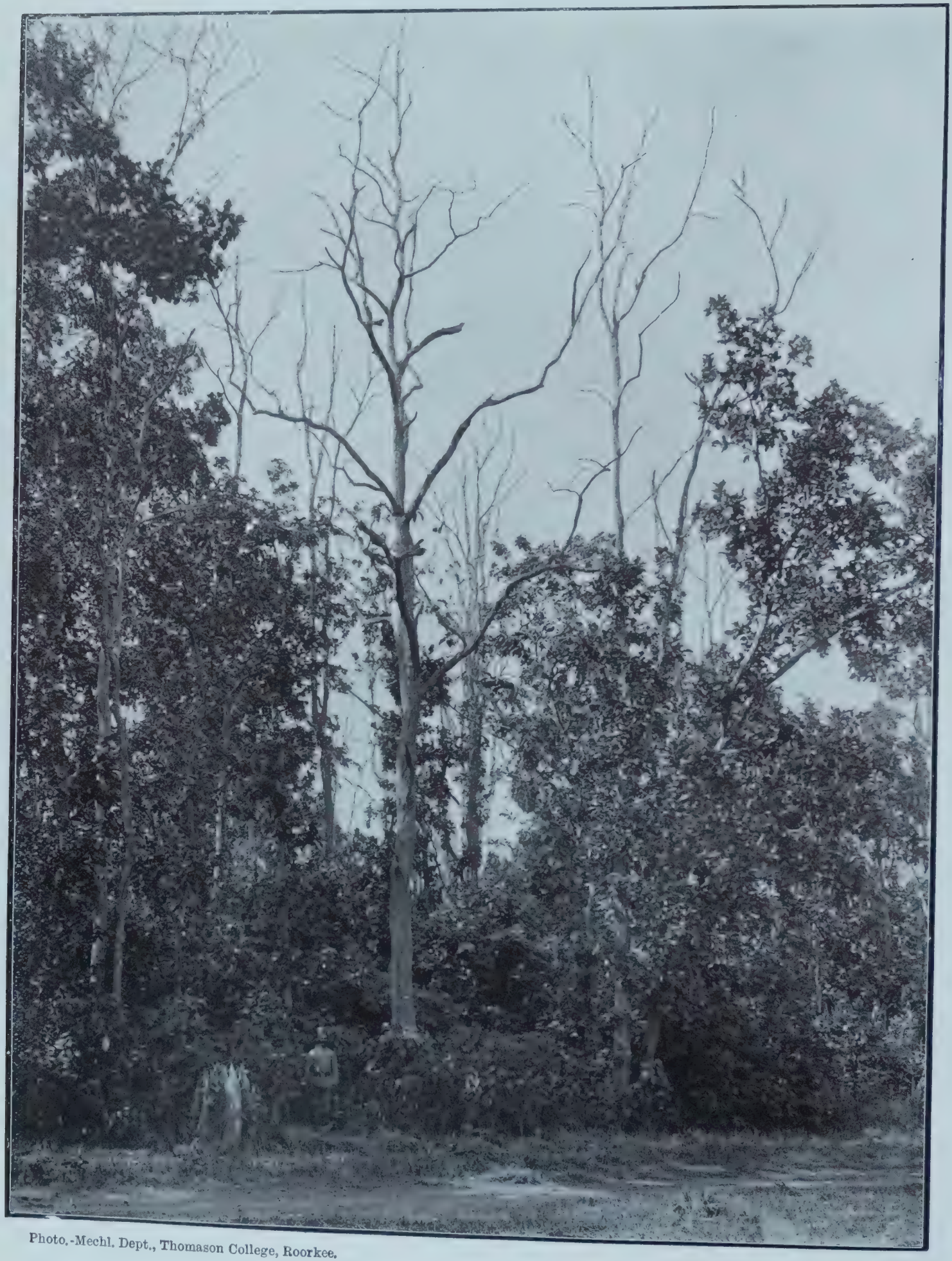

Photo.-Mechl. Dept., Thomason College, Roorkee.

DRYING-UP OF TREES IN SMALL GROUPS.
WEST LEHRA FOREST, GORAKHPUR DIVISION U. P.

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again in 1908, however, resulted in the extensive drying up of the trees which started about the end of 1908 and beginning of 1909 and continued throughout the dry weather of 1909, and although the rainfall that year was sufficient it was too late to save the situation. There is little doubt, however, that a heavy rainfall in April 1909, followed by an early burst of the monsoon that year, was of great benefit in checking further damage, and in some places it was even noticed that trees which appeared to be dead recovered when the rain fell in April.

Appearance of forests affected.

The extent of damage varied considerably. In some places the trees died sporadically, while frequently they dried up in comparatively small patches as shown in Plate II. In the more severely affected areas considerable stretches of forest, many acres in extent, were killed. This form of damage, of which the photographs in Plate I give some idea, was most prevalent in the cis-Sarda forests of the Kheri Division. These affected areas were often sharply marked off from adjoining unaffected areas : the explanation of this phenomenon, which is discussed in Section 9 below, is to be found in the presence of thick strata of pure sand in the subsoil of the affected areas.

Trees affected in varying degrees.

Although large numbers of trees were killed outright, many dried up only partially : of these some died subsequently, but many survived owing to the timely rain in April 1909 and the early burst of the monsoon in that year. It is probable, however, that the vitality of most of these survivors has been permanently affected : many of them remain stag-headed and covered with epicormic branches. As a general rule the *Sál* trees which suffered most were those of the II and III classes (*i.e.*, 3-6 ft. in girth) while I class trees (over 6 ft. in girth) also suffered considerably : small trees were least affected. A possible explanation of this fact is given in Section 6 below.

5. Effect of Drought on Different Species.

Factors influencing effect of drought on different species.

The precise reason for drought-hardiness, or the reverse, in trees of different species is no doubt largely physiological, some trees adapting themselves by nature to resist drought. On the other hand the root-system, in its relation to the subsoil, evidently has an important influence. Well-borings throughout the affected areas have shown that in these areas there is invariably a stratum of pure sand or very sandy loam in the region of or immediately above the permanent water-level. This sandy stratum has little capacity for retaining water, and when the water

level sank it became comparatively dry, whereas the more clayey strata nearer the surface not only had greater capacity for retaining moisture but even received a certain amount of water from the scanty rainfalls of 1907 and 1908.

These considerations would lead us to suppose that the deeper-rooted species would suffer to a greater extent than the more shallow-rooted species: and this was in fact the case, for in the list given below it will be seen that the deep-rooted species as a rule were the most severely affected, while the surface-feeders proved to be more hardy.

Hardiness or otherwise of different species: *Shorea robusta* and *Terminalia tomentosa*.

Sál (*Shorea robusta*) suffered more than any other species, and may be regarded as very susceptible to drought. *Terminalia tomentosa* was somewhat less affected, but suffered severely, and may be regarded as a decidedly drought-tender tree.

Miscellaneous species.

Most of the miscellaneous species in the *Sál* forests stood the drought well, some escaping damage altogether: the following list gives, as nearly as possible, the relative hardiness of most of the commoner species, as observed during the period of the drought:—

CONSPICUOUSLY HARDY.

Ficus Spp. (noticeably *F. religiosa* and *F. bengalensis*).
Diospyros tomentosa.
Stereospermum suaveolens.
Miliusa velutina.

DECIDEDLY HARDY.

Gardenia turgida.
Schleichera trijuga.
Holarrhena antidysenterica.
Ougeinia dalbergioides.
Cassia Fistula.
Cordia Myxa.
Bauhinia racemosa.
Casearia tomentosa.
Butea frondosa.
Bridelia retusa.
Odina Wodier.
Eugenia Jambolana.
Ehretia lævis.
Mallotus philippinensis.
Carissa spinarum.
Lagerstræmia parviflora.
Careya arborea.
Grewia asiatica.
Kydia calycina.
Randia uliginosa.
Randia dumentorum.
Zizyphus xylopyra. *
Ægle Marmelos. *

* These two species were observed to be affected by drought to some extent: it should be noted, however, that they are frequently found on the driest and poorest soils where most species will not grow, and in surviving the drought in such localities they may be regarded as decidedly hardy. Where found on better localities they were entirely unaffected.

FAIRLY HARDY.

Adina cordifolia.	*Wrightia tomentosa.*
Stephegyne parvifolia.	*Albizzia procera.*
Terminalia belerica.	

In the submontane forests of the Gonda Division *Anogeissus latifolia* suffered rather severely.

Accacia Catechu and Dalbergia Sissoo.

In the forests of the lower and recent alluvium, where *Acacia Catechu* and *Dalbergia Sissoo* abound, the damage by drought was not severe, as the water-level probably did not sink to any great extent. In Gonda Division Babu Gulab Rai notes that III class trees of *Sissoo* were affected. In other localities visited, where these species occurred in the neighbourhood of the *Sál* forests, they were decidedly hardy, since trees raised in former sowings in blank areas were found to be entirely unaffected by the drought.

Trees in swampy localities.

In Gonda Division it was noticed that trees growing in swampy localities along streams, such as *Eugenia Jambolana, Barringtonia acutangula, Salix tetrasperma* and *Trewia nudiflora*, were affected by drought when the streams dried up.

Mango and Mahua groves.

In Kheri District mango topes suffered severely in many places, some having been entirely destroyed; in Gonda and Bahraich the damage to mango and mahua (*Bassia latifolia*) groves was not so great.

Climbers.

The most important climbers in the affected forests are *Bauhinia Vahlii, Spatholobus Roxburghii* and *Millettia auriculata*. These remained perfectly green and vigorous even in badly affected areas. In such places there can be little doubt that the climbers, favoured by the opening of the canopy, will give some trouble in future.

6. Effect of Drought on *Sál* Trees of different Sizes.

It has been mentioned above that *Sál* trees 3 ft.-6 ft. in girth suffered most, and that those over 6 ft. in girth also suffered considerably, while small trees were least affected. A possible explanation of this fact may be found in the relation of the root-system to the source of water-supply, and the remarks in the last section regarding the comparative immunity of surface-feeders would apply to some extent here. As a rule *Sál* trees 3 ft. and over in girth are up to a certain point in full

vigour, with crowns and root-systems well developed, the latter probably drawing the bulk of their water supply either directly from the permanent water-bearing stratum or from the subsoil immediately above it: the abnormal lowering of the water-level with the consequent dessication of the subsoil above it would thus deprive the root-system of the minimum supply of water necessary to counterbalance the loss of moisture by transpiration. In the case of the smaller trees the crowns and root-systems are less extensively developed, and the latter possibly draw much of their water supply from strata nearer the surface, into which water would soak downwards to at least some little distance from the surface during the years of scanty rainfall. This surface water would appear to have been sufficient to counterbalance the moderate amount of water lost by transpiration in the case of the smaller trees with their less extensive crowns.

7. Effect of Sylvicultural System.

Superiority of high forest over coppice-with-standards.

The only sylvicultural systems in force in the affected areas are (1) selection and improvement fellings, and (2) coppice-with-standards. In the cis-Sarda forests of the Kheri Division the damage was so intense that the forests worked under either system appeared to be equally affected, the coppice suffering nearly if not quite as much as the standards in coppice-with-standards: it is more than probable, however, that much of the damage to the coppice was due to frost following on the drought. Elsewhere, the marked superiority of high forest over coppice-with-standards was noticeable. In the latter system the coppice as a rule escaped lightly, but the standards were badly affected: even where the coppice was killed back it usually sprung up again from the stools, which kept alive. Plate III shows a typical coppice-with-standards area in which the standards have been almost entirely killed out, the coppice sustaining comparatively slight permanent injury. Coppice growth in coupes felled during the years of drought, however, was poor, since the stumps of trees affected by drought gave few or no coppice shoots: this adverse effect of the drought will probably be noticeable in coppice coupes for some time to come.

Example in Gorakhpur Division.

A striking example of the superiority of high forest over coppice-with-standards was to be found at Ramgarh in the Gorakhpur Division. Here a straight road, that is a perfectly artificial boundary, separated certain coupes in which the coppice had been cut within the past 6 years from forest not yet cop-

Photo.—Mechl. Dept., Thomason College, Roorkee.

EFFECT OF DROUGHT ON SAL COPPICE WITH STANDARDS.
TIKRI FOREST, GONDA DIVISION, U. P.

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piced, and still in the state of high forest. The latter was hardly affected at all, whereas in the coppice coupes a very large percentage of the standards were killed by the drought, the damage stopping short at the road.

8. Some Physical Factors in their Relation to Drought.

Atmospheric moisture.

No systematic observations were made to compare the humidity of the atmosphere during the years of drought with the humidity during normal years. With regard to Kheri Division, however, Mr. Canning observed that in the trans-Sarda forests in the cold weather of 1907-08 and 1908-09 morning mists were practically unknown, and the dew was very light, whereas in normal years the cold weather is characterized by misty mornings and heavy dewfall. Ordinarily in the trans-Sarda forests the atmospheric humidity is considerably greater than in the cis-Sarda tract.

Diminution of surface water.

Throughout the affected tracts a feature of the drought was the drying up of streams, lakes and swamps. In the Kheri Division Mr. Canning records that in the cis-Sarda tract all surface water disappeared. In the Ul Nala which traverses these forests, water in the early part of 1909 was first found at a point 25 miles lower down its course than in 1894. In the trans-Sarda forests most of the large lakes and swamps in the *Sál* areas had completely dried up. The Soheli river was dry down to the point where the Newra Nala, which rises in Nepal, flows into it near Dudua : the latter stream was little affected by the drought. Water in the Jauraha Nala, which flows almost its whole course through reserved *Sál* forests, was found only low down in its course, and the Mohan river, which skirts the Nepal border, was practically dry for the whole of its length adjacent to the reserved forests.

Effect of configuration. Hills and plains.

The small extent of damage done by the drought in the Sub-Himalayan outer hills as compared with the plains tracts has been noted above. The probable explanation of this is that the plains *Sál* forests are situated on alluvial ground, in which the permanent subsoil water-level is nowhere at a great depth. The deeper-rooted trees are thus dependent on the water-level for their supplies of water, of which they were to a considerable extent deprived when the water-level sank during the years of drought. On hilly ground, however, the water-level is not at a regular distance from the surface, and is sometimes at a considerable depth, and the trees are not directly dependent on it to the same extent ;

moreover, the soil is comparatively shallow, and even in years of ordinary rainfall a considerable proportion of the rain water flows off without permeating it. In the years of scanty rainfall it is probable that there was sufficient water to saturate the soil, even if there was little or no excess to be carried away by streams. It would be natural to suppose, therefore, that a deficiency of rainfall would not have so serious an effect on the vegetation of the hill slopes as on that of the plains.

"Damars" and other banks.

In the plains *Sál* forests a feature of the alluvial formation is the presence of "damars" or old river-banks, separating the higher and older deposits from the lower and more recent ones. These forests also contain depressions representing former lakes, swamps, or streams, and having more or less well-defined banks. It was noticeable that the trees suffered more severely along the tops of these "damars" and banks than on the adjacent level ground. Probably the reason was that the dessication of the soil was more pronounced along these banks than elsewhere owing to their more exposed situations.

9. Relation of Subsoil to Damage by Drought.

Kheri cis-Sarda forests.

In certain localities a feature of the damage by drought was the manner in which trees were killed off in patches of varying extent, while adjacent areas escaped partly or entirely. This was particularly marked in the Kheri cis-Sarda forests, where there were patches, often many acres in extent, in which every *Sál* tree was killed, while adjoining these, and sharply marked off from them by a green wall of vegetation, were patches in which not a tree was injured. An examination of the surface revealed no possible explanation of this phenomenon, and accordingly an attempt was made to ascertain, by digging wells, whether it could be accounted for by any difference in the subsoil of the affected and unaffected areas respectively.

Well-borings.

Two contiguous areas, one badly affected by drought and the other quite unaffected, were accordingly selected, and six wells were dug down to water-level, commencing in the centre of the affected area and following a straight line across that area and on to the centre of the unaffected area. The soil was examined on the spot in detail from the surface to water-level. The wells were dug in February 1910, that is a year after the drought was at its worst, and the water-level at that time was at a depth of $21\frac{1}{2}$ feet from

the surface in each well. The following is a summary of the observations made :—

Well No.	Distance from previous well.	Position of well.	Nature of soil and subsoil down to water-level.
1	..	In middle of badly affected area.	Soil and subsoil in wells Nos. 1 to 4 identical, *viz.*:—
2	50 yds.	In badly affected area.	*Surface to 8′*.—Rather stiff clayey loam. *8′—10′*.—Sandy loam.
3	25 yds.	Do. do.	*10′—21½′* (*water-level*).—Pure sand. Nodules of *kunkur* in sand at water-level : this sand with *kunkur* nodules extended as far as could be probed under the water.
4	98 yds.	On edge of badly affected area.	
5	52 yds.	In unaffected area. Trees all green.	Soil and subsoil in wells Nos. 5 and 6 identical, *viz.*:— *Surface to 8′*.—Rather stiff clayey loam. *8′—10′*.—Sandy loam.
6	55 yds.	Do. do.	*10′—21½′* (*water-level*).—Beds of clayey loam with occasional bands of sandy loam : near water-level was a bed of stiff moist blue clay which extended as far as could be probed under the water. No *kunkur* found.

Probable explanation of phenomenon of drying up in well defined patches.

There can be little doubt, from these observations, that the drying up of the trees in the affected area was due primarily to the presence in the subsoil of a thick layer of pure sand. Experiments made with a number of different soil samples from other drought-affected localities—by means of open-ended glass tubes containing the samples, having their ends placed in a vessel of water—showed that the rate of ascent of water in the sandy soils was a great deal more rapid than in the case of the clayey soils, as also was its rate of fall when the water-vessel was removed. The cis-Sarda borings indicate, therefore, that when the water-level sank the sandy subsoil of the affected area was unable to retain a sufficiency of moisture to keep the trees alive, whereas in the unaffected area the clayey subsoil always retained a percentage of moisture above the minimum required to support the forest growth.

Geological origin of subsoil in affected areas.

The whole of the cis-Sarda tract being of alluvial origin, it is probable that the thick beds of pure sand represent former sand-banks which were formed by river action and are now buried several feet

below the surface owing to the later superimposition of more clayey beds. This would explain the fact that in many cases the affected areas, denoting the occurrence of these sand-banks in the subsoil, were long and narrow in shape, and were observed to follow regular lines of varying breadth.

Well-borings in other localities.

The drying up of trees on definite patches, which was so marked a feature in the Kheri cis-Sarda forests, was noticeable to a considerable extent in some of the other affected localities, but nowhere was it so conspicuous as in the former forests. With a view to confirming the results of the cis-Sarda borings, Divisional Forest Officers were asked to have similar well-borings made in adjacent affected and unaffected areas. Soil samples from each well, taken at 2 feet intervals from surface to water-level, were collected and examined, but in no case was there any marked difference in the samples from the affected and unaffected areas respectively, as in the case of the cis-Sarda experiments. Many of the areas concerned were subsequently visited, but in no case was the distinction between the affected and unaffected areas found to be so well marked as in the cis-Sarda forests, while in some cases there appeared to be no distinction at all. These well-borings were not made till May 1910, by which time the water-level had risen considerably, and this in itself might have vitiated the results to some extent.

10. Effect of Undergrowth on Damage by Drought.

As regards the effect of undergrowth in preventing damage by drought, it would be reasonable to suppose that the presence of dense undergrowth would be beneficial in retaining moisture in the soil by preventing evaporation. From actual observations, however, it was difficult to form any conclusions on the subject. The earliest visit made to the drought-affected region was to the Kheri cis-Sarda forests, a year after the drought: the undergrowth in the unaffected areas was then certainly denser than it was in the damaged areas, but since much of the undergrowth in the latter was killed by the drought, it is difficult to say whether or not the difference in density was so apparent before the years of drought. That the presence of dense undergrowth had little or no effect in saving the deeper-rooted trees was apparent in the trans-Sarda forests and elsewhere, the larger *Sál* trees dying sporadically as much in areas with dense undergrowth as in areas where the undergrowth was scanty.

11. External Dangers in Relation to Drought.

Fire.

The presence of so much dead timber in drought-affected areas, combined with the heavy crop of coarse grass where the forest has been opened out by the dying of the trees constitutes a serious menace to fire-protective operations. The damage done by fire in such an area in 1909 in the Fort Range of the Kheri Division was enormous, many of the smaller trees, already to some extent affected by the drought, being entirely killed and consumed by the fire. It was noticed in this case that of the trees which were killed by drought, those which still had the dead bark clinging to them suffered much more than those from which the bark had fallen off. Where dead bark was present the fire ran up the tree, sometimes consuming the whole stem, whereas if there was no bark the stem was usually burnt only at the base, except in the case of small trees which had no chance of escaping destruction.

Frost.

There were no abnormally severe frosts during or immediately succeeding the years of drought, and yet the adverse effect of frost in conjunction with drought was painfully evident in the cis-Sarda forests of the Kheri Division, where during the cold weather of 1908-09 much of the coppice growth was killed by frost, partly owing to the shoots having already suffered from drought, partly owing to the opening of the overwood by the drying up of the standards, and partly owing to the abnormal dryness of the atmosphere, a condition which would naturally intensify the effects of the frost. It is to be feared that this opening of the overwood will have an adverse effect in the case of frost damage in future.

Climbers.

The drought-resisting nature of the noxious climbers, the spread of which will probably be encouraged in forest opened out by drought, has already been alluded to at the end of Section 5.

Insects.

No abnormal spread of insect pests has yet been observed as a result of the presence of so many half dead trees, though the multiplication of wood-borers in affected areas is a possible menace.

12. Effect of the Drought on the Present Working and on the Future of the Forests.

Modifications in the working-plans.

As a result of the drought the Kheri cis-Sarda working-plan has been entirely cancelled, and nothing but dry-wood fellings are to be carried out until further

notice. The trans-Sarda working-plan has been revised so as to give complete rest to the most severely affected areas—5 compartments aggregating 10,068 acres.

In Pilibhit, Gonda and Gorakhpur the prescriptions of the working-plans have been modified temporarily to provide for the removal of dry timber. No such modification has as yet been introduced in Bahraich, but as a result of recent inspections Mr. Clutterbuck, the Conservator, states that a revision of the working-plan will certainly be necessary in respect to areas where the drying up of trees is excessive.

Recovery of forests from effects of drought.

The recovery of the forests from the effects of the drought must of necessity be slow, but even in 1912 there were signs of the affected areas becoming filled up with young growth. In the types of *Sál* forest in question the tendency of the *Sál* to regenerate freely in forest which has been heavily opened out is well known, and as there has survived in most places a fair undergrowth of such excellent *Sál* nurses as *Holarrhena*, *Wrightia*, *Mallotus* and other species, the successful regeneration of the *Sál*, given successful protection from fire and grazing, is only a matter of time.

In the worst areas, such as in parts of the Kheri cis-Sarda tract, where all the *Sál* seed-bearers have been killed out over extensive patches, the outlook is not so hopeful ; at present many of these areas have reverted to grassy blanks, but these may in time be expected to fill up, first with frost-hardy miscellaneous species and possibly later with *Sál*. A proposal was made to carry out the artificial re-stocking of the cis-Sarda forests with the aid of irrigation, but this idea was abandoned owing to financial and other difficulties.

13. Measures for the Prevention of Damage by Drought in Future.

A severe drought like the one in question is one of the many instances where man is peculiarly helpless against the forces of nature ; it is therefore impossible to devise any practical measures which would entirely counteract similar damage in case of another severe drought, and any suggestions on the subject are made rather with the idea of lessening the extent of damage in the event of a similar catastrophe in future. With that end in view the following remarks are made :—

(1) Standards in coppice-with-standards have been found more susceptible to damage than trees in high forest, and where the objects of management allow it, the working of forests under high forest would appear advisable in areas which

have suffered severely in the recent drought. It is not proposed here to discuss the merits of simple coppice as against coppice with standards, but it is a question which might be considered should occasion arise.

(2) The retention of a suitable mixture of drought-hardy trees in the *Sál* forests is desirable : a list of these is given in Section 5.

(3) An undergrowth of drought-hardy species is of special importance : even though the presence of heavy undergrowth has not been proved to prevent damage by drought, the value of an extensive undergrowth of hardy species as a soil covering will be very great in the event of any future destruction of the overwood by drought.

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Note on the Preparation of Indian Forest Floras and Descriptive Lists.

BY

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PREPARATION OF

INDIAN FOREST FLORAS

AND

DESCRIPTIVE LISTS.

INTRODUCTION.

1. There are possibly to-day, as there were in 1874, the date of publication of Brandis' *Forest Flora of North-West and Central India*, some who consider that a competent Forest Officer only requires to know the more important large trees occurring in his forest. For the benefit of such the author of that invaluable book remarked: "Foresters in India will gradually understand that they are expected to make the utmost of the estates entrusted to their charge ..... and this will lead them eagerly to seek information regarding the various trees and shrubs which may be turned to account. It is not possible to predict in what respect any particular plants may not eventually be found useful .... The only safe plan, therefore, is at the outset to take a comprehensive view of the whole forest vegetation, instead of confining our attention to those trees which we are accustomed, often erroneously, to regard as most important." (l. c. p. x.) In the present year of 1913 when insignificant herbs like violets (*banafsha*) yield an annual forest revenue of some R10,000 in Kashmir and when there is every prospect of a revenue of some Rs. 3 per acre for paper-pulp being obtained from many of our coarse savannah grasses which cover vast areas in North India, there is probably no need to emphasize the importance of a good knowledge of our forest vegetation generally and not only of our large timber trees.

2. Although the importance of such knowledge is generally recognized, however, it is an undoubted fact that the majority of Forest Officers do not as yet possess it. It is a significant point that many commercial forest products at present appear in the Divisional schedules of rates under their vernacular names, the scientific names being unknown. No less significant is the following extract from the *Catalogue of Exhibits in the Forestry Court of the United Provinces Exhibition, 1910* (Allahabad 1912): "perhaps the most striking feature of the Catalogue

is the very large number of minor products obtained from trees and shrubs whose scientific names were unidentified." This lack of knowledge again is evidenced by the frequent difficulty with which information is obtained from local officers regarding the local distribution, yield, etc., of any but the most common products. For many years past it has in fact been realized that the average forest officer in India has neither the leisure nor the botanical knowledge necessary for the successful identification of species by means of the Floras now in existence, and that, to remedy the existing unsatisfactory state of affairs, the Forest Department urgently requires a supply of simple books which the ordinary officer of average intelligence can easily use and understand.

3. Notwithstanding the strong and practically unanimous opinion which has prevailed for many years regarding the necessity for such books, no systematic effort has been made to secure their preparation and publication. The chief reason for this delay is to be found in the idea that the books required must necessarily be more or less detailed *Floras*, the preparation of which for the forests of India and Burma would necessitate a number of skilled botanists being placed on special duty for a considerable period. It was considered that sufficient botanical power was not available in the Department for such an undertaking and that there would be objections to placing a number of officers on special duty for this work for a considerable period. In 1911 the writer pointed out the advisability of drawing a distinction between *Floras* and *Descriptive Lists* and of commencing this work with the systematic preparation of *Descriptive Lists*. (*Indian Forester* XXXVII, pp. 545-552.) The following year the question was taken up by the Government of India and Circular (Department of Revenue and Agriculture) No. 20-F-105-6, dated 30th September 1912, requested Local Governments and Administrations to commence the work of preparing Descriptive Lists as soon as convenient. It was also considered desirable that, for the guidance of local officers, the scope and function of the proposed Lists should be precisely and clearly defined and for this purpose the writer was directed to prepare a note on the subject for the consideration of the Board of Forestry at Dehra Dun in March 1913. The scheme outlined in that note is reproduced below and the following resolution was passed thereon by the Board of Forestry :

(i) That detailed Forest Floras are useful for purposes of reference and that their ultimate publication is an object which should be kept steadily in view.

(ii) That the preparation of detailed Floras is not of such urgent importance at the present time as is the preparation of Descriptive Lists.

(iii) That the scope and general character of the Descriptive Lists, as detailed in para. 2 of Mr. Hole's note and in appendices I, II, IV and V (with Schedule) thereto, are generally suitable.

(iv) That the preparation of Descriptive Lists should be undertaken in the various provinces as soon as circumstances permit.

(v) That it is desirable that the preparation of the Lists should, as far as possible, be undertaken on uniform lines in all Provinces.

(vi) That the precise area to which each List should apply should be decided by Chief Conservators and Conservators in consultation with the Forest Botanist, subject always to the approval of the Local Government.

(vii) That specimens of all species collected by officers who work on these Lists and Floras should be placed permanently on record in the Dehra Dun Herbarium.

On this resolution the Government of India passed the following orders :—" The Government of India have considered this Resolution with care, and agree that the preparation of descriptive lists in accordance with Appendix F to the proceedings of the Board will ordinarily be sufficient for present practical requirements and is the first step to be taken. They therefore accept this Resolution generally, and trust that Local Governments will now undertake the preparation of Descriptive Lists on the lines referred to in parts (iii) and (vi) thereof. They desire, also, to invite attention to the remarks in paragraphs 6 and 7 of Mr. Hole's note (Appendix F) regarding the necessity for supervision by Conservators and co-operation with the Research Institute in preparing the Descriptive Lists. The questions of the manner in which, the agency by which, and the areas for which, floras should be prepared will be decided after the Descriptive Lists have been completed. "

There is thus good reason to believe that this work will now be systematically and energetically taken in hand.

4. The chief advantages claimed for the scheme of Descriptive Lists are that :—

(*a*) A useful beginning can be made where trained botanists are not available and where no officer can be placed on special duty for the work.

(*b*) It provides for the rapid preparation of simple books in all

Provinces which can be readily understood by a Forest officer of average intelligence but with no special botanical knowledge and which will enable him to identify the important species in his forests.

(*c*) It will facilitate the ultimate preparation of detailed reference Floras.

The primary object of the Descriptive Lists, therefore, is to facilitate the work of identification for the non-botanist and its practical utility consequently depends almost entirely upon—

(1) The keys to the species.

(2) The vernacular names.

The primary importance of these, therefore, cannot be impressed too strongly on the authors of the Lists. To make the keys intelligible and useful to the average Forest Officer, minute botanical characters which require a dissecting microscope for their determination must be avoided and far freer use must be made of field-characters than is usually the case in the botanical keys of Floras. There is a tendency on the part of some Forest Officers to believe that the correct definition of species necessarily depends on abstruse technical characters which the ordinary man can neither hope to recognize nor understand. In most good species, however, minute botanical characters (which are naturally of most value to the systematic botanist working in a herbarium with as a rule only scanty material) can be correlated with other and more obvious characters which serve to distinguish the species in the field and which are naturally of primary importance for the field-student. Indeed it is probably not too much to say that, as a general rule, if the careful field observer after due study fails to discover characters which enable him to recognize the herbarium botanist's species as a definite and distinct group of individuals in nature, it is so much the worse for the herbarium species which thus becomes of no practical forest value.

The primary task of the authors of Descriptive Lists, therefore, is to translate the work of the systematic herbarium botanist into such terms as shall be readily intelligible to the average Forest Officer and thus to enable the latter to reap the full practical advantages of the labours of the systematist. The discovery and selection of the field-characters required for the keys, therefore, will necessitate much hard work in the field and a real knowledge of each species as it appears in the forest. Hardly less care and labour will be required for the selection of

really useful and reliable vernacular names. Such labour, however, will be well repaid by the cordial appreciation of those Forest Officers who try to use the completed Lists and who will be the ultimate judges of their practical utility. From what has been said above it will be seen that, although the co-operation of the systematic botanist is essential, inasmuch as he supplies the foundation of identifications on which the present work must be based, the actual preparation of the Lists can be quite well done by the average trained Forest Officer. Indeed it is possible that the very important keys will be more satisfactorily prepared by the latter than by the expert systematist, inasmuch as the latter will be more inclined than the former to utilise and depend on minute technical characters.

5. Regarding the question of recording vernacular names, it is advisable to draw attention to a point which is frequently overlooked, *viz.*, that by no means all useful vernacular names have a definite *meaning*. Many names have become so changed in the process of vulgarisation that their original form and meaning (if they ever had any) are no longer traceable, but this in no way detracts from the value of such names in the districts in which they are in use. Such names must obviously be recorded as they are spoken and should not be altered into what the etymological expert thinks they ought to be, in which case they become no longer recognizable to the local people. The main object to be borne in mind is to get names on record which are likely to be recognised by the local natives and by the officers who have to work with them and for this reason we must accept useful vulgarisms. With the object of securing uniformity as regards this question it is suggested that the following procedure should be adopted by the authors of Descriptive Lists.

(*a*) Each name should be recorded exactly as it is pronounced by the natives of the locality in question and the locality in which they are current must be recorded.

(*b*) So far as possible each name should be written in the vernacular character on the spot by a literate native and the dialect, when known, should be noted.

(*c*) The vernacular names should be transliterated into English according to an accepted system of equivalents.

(*d*) When vernacular names have a definite meaning in the language in question, this meaning should be recorded.

(*e*) When names are recorded directly in English, phonetically, this fact should be clearly stated.

(*f*) Even natives who know their trees well are not infallible and care should be taken, when possible, to select individual plants exhibiting those characters which are most likely to be recognised by the native questioned. The names of species which are confused by natives when in leaf, for instance, should be recorded from plants in flower or fruit.

(*g*) In the case of species which closely resemble each other, their vernacular names should be recorded when both species are situated close together and can be readily compared.

(*h*) No name should be finally accepted as correct which has not been verified by inquiry from at least two different individuals, in different localities.

(*i*) If, on being questioned, a native does not give a name quickly, and spontaneously, it is generally useless to continue questioning or a name will probably be invented.

(*k*) In some dialects certain letters are freely interchangeable and where inquiry shows that this is the case the fact should be recorded.

6. The precise area to be included in each Descriptive List is a question which requires careful consideration. The chief points to be borne in mind are:

(1) The number of species dealt with must not be so large as will render the preparation of simple keys impossible. The number of species depends (*a*) on the general lines prescribed for the selection of species, see para. 2 (*a*) and 6 (*c*) of the accompanying note, (*b*) on the extent of the area and (*c*) on the general type of the flora in the locality concerned.

(2) Where the type of the flora permits, without prejudice to the preparation of efficient keys, it is more convenient and far cheaper to include a large rather than a small area in each list. At the same time it must be remembered that when it is impossible to put an officer on special duty for the work, it is preferable to deal with a comparatively small area, inasmuch as this will enable the officer responsible for the list to personally collect a large proportion of the information he requires and to

obtain a first-hand knowledge of the chief types of vegetation dealt with, instead of depending mainly on the contributions of other Forest Officers, and on the work of his collectors. This is essential if the work is to aim at completeness and reliability.

(3) The area dealt with should be defined by definite boundaries which can be clearly marked on a map so that there can be no doubt as to the tract which each List is intended to serve. For the convenience of those officers who will use the Lists it is also advisable to make these boundaries coincide, so far as possible, with those of Civil Districts or Forest Divisions.

At the same time the convenience of the greatest number of officers must necessarily override the convenience of individuals and will render exceptions necessary to this rule. A hypothetical case which is likely to occur, for instance, is that of a single Forest Division comprising a complicated hill-flora and also a comparatively simple plains-flora, while the latter also covers the entire area of several other adjacent Divisions. In such a case it would be obviously advisable in the interests of the latter Divisions to have two Lists, one dealing with the plains-flora, and one with the hill-flora, although this would necessitate the use of two lists in a single Division.

Note on Forest Floras and Descriptive Lists.

*(Prepared for Board of Forestry, 1913.)**

Necessary to distinguish Flora and Descriptive List.

1. The question of Indian Forest Floras has been greatly confused and the preparation of suitable books has been considerably retarded in the past by the fact that no attempt has been made to clearly define the exact nature of the publications concerned. Thus it has been customary, hitherto, to use the term Flora in a loose sense for various publications which differ very widely in the essential particulars of scope, function, time and knowledge necessary for their preparation and cost of production. Clear definition of the publications concerned, therefore, is an essential preliminary to any profitable discussion of the subject and in the writer's opinion it is necessary, at the outset, to sharply distinguish between a true Flora and what may be conveniently described as a Descriptive List.‡

* Printed as Appendix F to the Proceedings of the Board of Forestry.

‡ The writer recognises that the distinction here drawn is more or less arbitrary but there is no doubt that some such distinction is essential.

General Scope and Function of Descriptive List.

2. Turning first to the subject of Descriptive Lists it is necessary to lay great stress on the fact that their primary object, which must override all other considerations, is to render the identification of all important forest species easy for all officers of average intelligence who may have no special knowledge of botany. In order to facilitate identification it is essential that these Lists should include full details of all reliable vernacular names in use in each Division and simple keys based, as far as possible, on characters which can be recognised in the forest and which will render identification possible at different seasons of the year. The information which in the writer's opinion ought to be included in these Descriptive Lists, when *complete*, is detailed below :—

(*a*) Species to be included—

All species should be included which are of special importance for the forest officer and which a competent forest officer ought to know or be able to easily identify. These are all indigenous trees, shrubs, strong climbers, bamboos and herbs of special economic importance (including important grasses other than bamboos). In addition, the principal non-indigenous trees and shrubs which are commonly cultivated in local gardens and avenues, or which have run wild in the area, ought to be included, on account of their possible importance in afforestation schemes and plantations. The non-indigenous species, however, might perhaps be conveniently kept distinct and placed in an appendix.

(*b*) Introduction—

This should contain a brief account of the locality dealt with, its soils and underlying rock, climate, the principal types of forest vegetation and past and present systems of management.

(*c*) Keys to the species—

This is a point of the greatest importance. So far as possible all the four classes of characters given below should be employed in the keys throughout.

(1) Habit, dimensions, bark, blaze, twigs, juice, buds and periodicity.
(2) Leaves.
(3) Flower and inflorescence.
(4) Fruit and seed.

It should then be possible to identify the species at different seasons of the year (*a*) when leafless, (*b*) when in leaf, (*c*) when in flower and (*d*) when in fruit. The precise arrangement of these keys and the question as to whether a single key based on one class of characters will suffice to lead direct to the species, or whether such separate keys should be constructed to lead up only to the Family or Genus with a final key to the species based on more than one class of characters, must depend on the area dealt with, the number of species included and their special characteristics. The important principle, however, should be accepted that detailed botanical descriptions of orders, families, genera and species are not required and must be replaced by simple keys leading to the species by means of characters which require no more than an ordinary pocket-lens for their recognition and which can be made out in the forest. It should also be accepted as the primary essential of an efficient List that it should be provided with not less than 2 simple keys to the species, based on different classes of characters, so that a reader failing to use one key may find it possible to get the species from another. Each key could of course include two classes of characters, *i.e.* one key might be drawn for flowers and fruits and another for leaves and habit, etc. Keys of the kind now alluded to have been employed by Dr. H. Marshall Ward in his *Trees* (1904-1908), where he has dealt with all the trees and shrubs indigenous in Britain together with those which are commonly cultivated there. Very similar keys are now employed in America and elsewhere, *e.g.*, in *Trees and Shrubs of Minnesota State*, United States of America, by F. E. Clements (1912). In Appendix I to this note extracts from the key based on leaf-characters, taken from Dr. Ward's *Trees*, are given as

an example of the kind of key required.* In addition to the characters there employed, such characters as the taste of leaves, their colour at different seasons, their colour when dried and others are of value in India and could be utilised in the key.

(*d*) Vernacular Names—

In the majority of provinces the vernacular names are of very great value for the identification of species provided they are carefully tested by competent inquirers and provided the area dealt with is limited. In dealing with large areas it is frequently found that one and the same name is used for quite different species which is apt to lead to confusion. All reliable vernacular names must therefore be recorded for every species with a note indicating the Divisions in which they are current. These names would be entered in the text under each species. The dialect when known should also be included.

(*e*) Description of Species—

It has been noted under (*c*) above that detailed botanical description of the species is not required but it would be an advantage to enter in the body of the list, under each species, a few of the more striking characters selected from those employed in the keys. The advantage of this is that when the reader is guided by the vernacular name to a particular plant, the brief characters given there will indicate whether this species is correct or not. The periodicity, *i.e.* period of flowering, fruiting, coming into leaf and leaf-shedding, should in any case be noted here.

(*f*) Habitat and Distribution—

In the body of the list under each species, its local distribution would be briefly noted, with type of forest, kind of soil, nature of locality in which it is usually found and its chief associates.

(*g*) Economic Uses—

The local economic uses would be entered briefly under each species. In addition, brief reference should be made to other uses

* In this key the metrical system has been used but in India for the present it is advisable to keep to the English system.

taken advantage of in other localities. This is advisable as, occasionally, the true value of a plant is not known in certain localities.

(*h*) References—

References should be given to Brandis' *Indian Trees,* Gamble's *Manual,* any detailed Local Flora of importance, *e.g. Bengal Plants* by Colonel Prain, Duthie's *Flora* or Cooke's *Flora* and Watt's *Commercial Products of India.* Such references will indicate to the reader where useful information regarding each species, which has not been included in the List, can be readily found.

(*i*) Key to principal woods—

This should be included and might be placed at the end of the List, following the account of the individual species. Mr. Gamble on pages xvii and xviii of his Manual has given examples of such keys, as he there remarks : " in order that Forest Officers who may desire to do it may utilize them in preparing local keys to the woods of their locality. After much consideration, I came to the conclusion that it would be useless to attempt to make a general key, not only because it would be an exceedingly difficult thing to do for so many species, but because when made it would be of little or no practical utility. A key, to be of use in any given locality, should not be complicated with references to numbers of kinds not found or likely to be found there, but should be short and refer only to those species of importance which are likely to be met with. Consequently, in my opinion, local keys would be much more useful than a general one, and need only take in a few kinds of wood."

(*k*) Sylvicultural and Oecological Lists—

Concise lists of the principal species arranged in order of merit according to their relative capacity to—

(*a*) endure shade,
(*b*) resist frost,
(*c*) coppice strongly,

(*d*) reproduce vigorously by root-suckers,
(*e*) thrive in very dry habitats, *e.g.*, bare rocky slopes and plateaus and very dry soil,
(*f*) thrive on water-logged soil,
(*g*) thrive on land-slips and on shifting sands,
(*h*) grow rapidly during youth,
(*i*) resist fire-damage,
(*k*) resist damage by grazing.

These Lists are of great importance to the forester both in his every day routine work and also in special schemes of afforestation and they should be included after the key to the woods. The number of lists which is advisable will naturally depend on the locality dealt with, thus (*b*) would not be required where frost is unknown and (*c*) would be of little value in a circle where there is no coppice management. As an example of the kind of list which is here alluded to, a sample is included in Appendix II. This is a tentative list of species arranged according to their susceptibility to frost damage which was drawn up by the writer chiefly from observations made in the Jubbulpore Division of the Central Provinces. Such lists even when incomplete are of considerable practical value when drawn up for limited areas and they can be easily and quickly prepared after a little careful and systematic study in the forest.

(*l*) Glossary—

A short glossary giving the meanings of the technical terms used in the list should be included

(*m*) Index—

There should be one index to scientific names and a separate index for vernacular names.

(*n*) Maps—

It would be an advantage if a map of the locality could be included showing, by colour washes, the distribution of the types of vegetation mentioned in the introduction as well as separate maps showing similarly the distribution of a few of the most important local species.

From what has been said above, therefore, it will be seen that the fully completed Descriptive List will form a convenient pocket-book which, by

means of vernacular names and simple-keys, will render easy the identification of all important species and which, by means of its introduction, sylvicultural lists and maps, will enable a Forest Officer new to the locality to rapidly obtain a knowledge of the nature and distribution of the local forest vegetation and of the chief characteristics of the principal species. In other words, he will at once be able to start his work on a basis of knowledge which under present conditions can only be laboriously acquired after years of observation and study.*

List should deal with a small area defined by political or administrative boundaries.

3. If now it is accepted that we ought to aim at producing Descriptive Lists which shall contain the information detailed in the last para, it is clear that each List can only deal with a comparatively small area and therefore with relatively few species. With an increase in the number of species, the keys on which identification depends will become increasingly difficult to prepare and difficult to use. It should also be noted that, these Lists being relatively small and cheap publications, overlap and duplication of work are of comparatively little importance in their case and such considerations must not be allowed to override the primary essential of making each list efficient and easy to use for the identification of plants. In the writer's opinion, as a general rule, a List should not deal with a larger area than that of a single Conservator's Circle and it may frequently be advisable to sub-divide a Circle, *e.g.* in Bengal. The question has been raised as to whether such lists should deal with botanical or political and administrative areas. This has been fully discussed by Colonel Prain in *Bengal Plants* I, pp. 1-5, where it is clearly shown that "the best system to adopt, because the most practicable, must be one that is based on a frank recognition of existing political frontiers, no matter how unscientific these may be." Where it is advisable, therefore, to sub-divide a Circle, the area included in each list should be defined so far as possible by the boundaries of one or more Forest Divisions or Civil Districts.

General Scope and Function of a Flora.

4. As compared with a Descriptive List, a typical Forest Flora should include "all that is known regarding the internal structure, the marketable products, the mode and rate of growth, the biological

*Nothing said above is intended to prejudice the publication of a List in an incomplete preliminary form. Such will indeed usually be advisable, but it is necessary to bear the complete scheme in view so that the information required can be steadily and systematically collected.

features, the sylvicultural requirements, the treatment in the forest, and the insect and fungoid enemies of the different species" (See Brandis' *Indian Trees*, p. vii). A Flora, therefore, should constitute a complete and detailed book of reference for Forest Officers and in fact approximates in character to what would be produced by amalgamating in a single work such information as is contained in Brandis' *Indian Trees* and Gamble's *Manual of Indian Timbers*. The botanical descriptions in a Flora should be detailed and sufficient to distinguish each species from all other nearly allied plants and should suffice for the identification of more or less incomplete material. These descriptions also should be supplemented by illustrations. The information under the other heads of diseases, sylvicultural requirements and economic uses should similarly be complete. Owing to the detailed nature of a Flora, extensive expert knowledge, a relatively long period of time and considerable expenditure are necessary for its production. In the case of such a work, therefore, it is advisable to deal with a fairly large area with the object of reducing overlap and duplication of work, as far as possible. As a general rule, such a book should probably not deal with a smaller area than that of a single province and in some cases it may even be advisable to group together two or more provinces. The primary object of a Flora being to serve as a complete book of reference, its size is a question of minor importance. Owing to the large number of species dealt with in a Flora and to the quantity of detail which must be included in it, it is impossible to provide it with short and simple keys and it therefore becomes more difficult to use for the purpose of identifying species. Such a book, therefore, while being essential for reference purposes, only partly meets the urgent requirements of the Department in respect of a publication which shall render the identification of all important species easy for all officers of ordinary intelligence.

Finally, the preparation of such a book should not be undertaken until the material collected for it is sufficiently complete to justify the hope that the book will not become quickly out of date, thus necessitating early additional expenditure on a revised edition. It is not generally realised that our knowledge of Indian forest vegetation is still very incomplete and that all detailed floras published under existing conditions rapidly become out of date. In Appendix III to this note is given a list of all Indian species of trees, shrubs, strong climbers and bamboos (exclusive of grasses) either new to science, or at all events new to India or Burma which have been published up to date since the appearance of Brandis' *Indian Trees* in 1906. This list is probably by no means complete but it

shows that roughly 100 species of importance to the Indian Forest Officer have been published in the short period of 6 years, the descriptions of which are not to be found, at present, in any existing Indian Flora, and that *Indian Trees* is thus already becoming out of date. It must be remembered, also, that this considerable addition of knowledge to Indian Forest Botany has taken place at a time when, in the majority of Forest Circles, no systematic collection or study of forest vegetation has been carried out and it is certain that, if such systematic study is now undertaken in all circles, a considerable number of new species will be discovered, even in regions which at present are regarded as comparatively well-known botanically. Thus, the systematic study of comparatively small areas, which is necessary for the preparation of the Descriptive Lists mentioned above, will serve a double purpose, inasmuch as it will provide the material which is essential for the preparation of complete and efficient Floras which will not rapidly become out of date. With reference to the utility of, and necessity for, a book of this description, it may be noted that Mr. Gamble, in 1910, referring to the question of issuing another edition of his Manual wrote that in his opinion "the really useful work would be a combination of a Flora (*e.g.* Brandis' *Indian Trees*) with the *Manual.*" This opinion was discussed and endorsed by the Board of Control which met at Dehra Dun in 1911. The necessity of having Floras of this type was also recognised by the Government of India in its recent Circular $\frac{20\text{-F}}{105\text{-}6}$, dated 30th September 1912. In Appendix No. IV to this note the scope and function of a typical Descriptive List and Flora, as described above, are respectively summarised, while Appendix V gives a summary of the detailed information which it is proposed to include in the Descriptive Lists.

Summary of Characteristics of List and Flora.

5. The general scheme which has now been formulated of undertaking the systematic preparation of Descriptive Lists as a preliminary step towards the ultimate compilation of detailed Floras has been now generally approved by the Government of India, *vide* its recent Circular No. $\frac{20\text{-F}}{105\text{-}6}$, dated 30th September 1912. As an indication of the general opinion of the Department regarding the scheme, it will be sufficient to quote the following opinions which have been very kindly sent me by (*a*) Mr. J. H. Lace and (*b*) Mr. H. H. Haines, the two foremost botanists

Opinions of Forest officers regarding the general Scheme.

at present in the Department, and by (*c*) Mr. G. S. Hart, Chief Conservator of the Central Provinces :—

(*a*) "I have suggested to my Government that a Descriptive List be first prepared for the Pegu Circle, ... With regard to detailed Floras I agree that one is required for Burma alone." J. H. Lace, 15th February 1913.

(*b*) "I agree with you that we want a List and a detailed Flora ..... Your scheme is an excellent one ..... Lay down the proper lines on which the scheme is to be evolved and wait for the men to turn up." H. H. Haines, 31st January 1913, and 22nd February 1913.

(*c*) "I agree entirely with the scheme for Descriptive Lists." G. S. Hart, 21st February 1913.

Lines on which work can be at once commenced.

6. The next question to be considered is the extent to which, and lines on which, this work of preparing Descriptive Lists can now be undertaken, under the conditions at present existing in the various provinces. With reference to this question it is in the first place desirable to deal with the following points, regarding which there has been a good deal of misunderstanding :—

(*a*) The opinion has been expressed that this work cannot be undertaken unless there are trained botanists available and unless their Local Governments are willing to place them on special duty for the purpose. Even under the most unfavourable conditions, however, in the case of a Province possessing no officers with special botanical knowledge and in which it is impossible to place a selected officer on special duty, it is quite possible to make a useful beginning. In the first place, for instance, it is clearly not necessary to delay publication, until the List can be produced in its completed form, with all the keys, oecological lists, maps, etc. A List can be first issued in a preliminary shape after say two years' work and if it is provided with the chief reliable vernacular names of the most important species and especially if it is possible to provide it with one simple key to the species (the preparation of which is certainly not beyond the powers of a trained Forest Officer of average intelligence), the list, even in its incomplete form, at once becomes of great value to local officers in helping

them to identify their species. In the second place, a Divisional Officer can, as a rule, be found who would be willing for a small honorarium to undertake the work in addition to his own duties. Such an officer would receive specimens from the other Divisional Officers of the Circle, would send them for identification to Dehra or Calcutta and would compile the information obtained. After the preliminary publication arrangements could be made to issue an annual *addendum-corrigendum*. An improved and revised edition would naturally follow in due course and in this way the List could be gradually perfected and good results obtained even in those Circles in which the most unfavourable conditions prevail. Conditions of this class are believed to obtain more or less in Bengal, yet the Conservator of that Province has written that he anticipates no difficulty in carrying out the work. At the other end of the scale we have those Provinces which not only possess thoroughly competent botanists but are, in addition, willing to place them on special duty for this work. These are the most favourable possible conditions and obtain in the Punjab and Assam. In these cases it should be possible to issue the complete Lists and possibly also concise Floras within a comparatively short period of years. All other Provinces may be said to lie between these two extremes.

(*b*) The next point regarding which misunderstanding appears to exist is with regard to the idea that the task of preparing the Lists must necessarily depend entirely on the efforts of a single individual and that the help of other Divisional Officers cannot be depended on. In the writer's opinion, the apathy of the majority of officers regarding this question is chiefly due to the great difficulty they now find in identifying their species. In a recent letter to the writer Mr. Perrée with reference to Assam justly says :—

"Few of us or our subordinates have taken any interest at all in systematic botany because of the hopelessness of things..... .....The men as they come from home or Dehra are bewildered at first, then indifferent. We want a book that will not only give a fairly full description but have full analytical keys. Brandis is too sketchy and seems to be of use only to the practical botanist."

In the writer's opinion, the publication of Descriptive Lists with one or two simple keys and vernacular names, even in an incomplete form will, to a very large extent, remove this difficulty and help to stimulate the interest of local officers. If this is not the case and if the majority of forest officers are found to be unable or unwilling to utilise the simple Lists for the study of their forest vegetation, it is most improbable that they will subsequently derive much advantage from the more detailed Floras which are naturally more difficult to use. Thus, if these Lists prove to be of no value, the entire case made out for this work of Forest Floras obviously falls to the ground. The writer, however, is convinced that if these Lists are properly prepared they will greatly facilitate identification-work and that local officers will therefore tend to make use of them to try and identify their local species, to collect notes regarding them and to send in specimens of doubtful plants for identification. Especially will this be the case if the local Conservator himself takes an interest in the matter and by punctually publishing periodic *corrigenda-addenda* does not allow the subject to drop out of sight. The possibility of securing this active co-operation of local officers is a point of the greatest importance and supplies a strong argument for insisting on the early publication of Lists in all Circles, even in an incomplete and preliminary form.

(*c*) The opinion has been expressed that a Descriptive List for a Province would often be of more value than such a List for each Circle. A decision on this point necessarily turns partly on the question of the species which should be included. If only a few selected species of important trees, shrubs and climbers are dealt with, it would undoubtedly be possible to produce a useful List with keys for an entire Province, but its utility would be restricted by its limited scope. In the writer's opinion, however, the view expressed by Sir Dietrich Brandis on this point should be accepted. He writes : "it may possibly be said that the present work as well as the Local Forest Floras of the future should be limited to the more important trees..... I came to the

conclusion that the usefulness of the book would be greatly impaired by such limitation ..... My ambition has been to publish a pathfinder through the bewildering variety of trees, shrubs, climbers, bamboos and palms, which constitute the forests in the different provinces of India. I do not maintain that foresters ought to know them all, but they ought to have the means of making themselves acquainted with them without undue loss of time." (Vide *Indian Trees*, p. ix.) In addition the writer thinks that all herbaceous plants of known economic importance found in our forests ought to be included, *e. g.* valuable drugs, edible products, fibres, dyes, etc. (such as *Podophyllum, Saussurea, Aconite, Chiretta,* and other *Gentianaceae, Elettaria, Amomum, Dioscorea,* many *Cucurbitaceae, Curcuma,* several *Araceae, Gerardinia, Rubia*), the more important grasses (apart from bamboos), and also the chief non-indigenous trees and shrubs which are commonly cultivated or which have run wild. This view has been accepted by Mr. Haines in his *Forest Flora of Chota Nagpur* (1910). If this view is adopted, it will almost certainly be found that a Province is, as a rule, far too large an area to deal with in a single list and that a single book dealing with a Province will usually rather approximate in character to a typical *Flora,* in which there are fewer keys to the species and which the non-botanist finds more difficult to use for identification purposes.

Necessity of placing the Botanical Collections on record in Dehra Herbarium.

7. Finally the writer would urge the necessity of a specimen of all species, collected by Officers who work on these Lists and Floras, being placed permanently on record in the Dehra Dun Herbarium. The Officers who prepare these books will be obliged to come to Dehra, not only to consult the herbarium, but also to make use of the sylvicultural and economic information available in the Files of the Institute, and it is most necessary that the botanical specimens supporting the records in the Lists and Floras should always be available at Dehra for reference. The proposal has been made that the local collections should be lodged in the local Conservators' offices. Past experience, however, has shown that suitable local arrangements for the *permanent* security of botanical collections from damp, fungi, vermin and neglect

are rarely possible. Mr. Perrée has written as follows on this point: "I agree entirely that Conservators' offices are not suitable for storing specimens. Mine certainly has not the necessary space." A collection of duplicates could of course always be placed in the local Conservator's office if desired.

APPENDIX I.

Ward's Key to British Trees based on Leaf-characters.

I. Leaves compound :—

A. Leaves opposite and on erect shoots usually decussate.

(1) Leaves imparipinnate.

(*a*) Leaflets broad more or less ovate on long petiolules, some of which twine as tendrils, shoots slender. *Clematis vitalba*, L.

(*b*) Leaflets more or less lanceolate on very short petiolules or sessile, never twining, shoots stout.

(*i*) Stipules represented by a thin interpetiolar ledge or line. Petiolules short. Venation reticulate with large meshes. *Sambucus nigra*, L.

(*ii*) Leaf exstipulate. Leaflets sessile or subsessile, venation pinnate. *Fraxinus excelsior*, L.

(2) Leaves palmately compound, digitate, exstipulate. *Aesculus Hippocastanum*, L.

B. Leaves alternate and spirally inserted on erect shoots.

(1) Leaves imparipinnate

(*a*) Leaves trifoliolate

(*i*) Leaves and shoots devoid of prickles or glandular hairs, leaflets small and delicate, entire, silky pubescent beneath

α. Leaflets 3–8 cm. long, silky pubescent beneath, as are also the young shoots : the latter not angular or furrowed. Stipules evident and persistent. *Cytisus Laburnum*, L.

β. Leaflets not more than 1–2 cm. long. Shoots angular and furrowed, glabrous. Stipules minute. *Sarothamnus Scoparius*, Koch.

(*ii*) Leaves not silky with prickles on the petioles and ribs ; leaflets large, coarse and irregularly serrate.

α. Prickles setaceous, deflexed but unequal, and not curved and claw-like, shoots

glaucous, leaflets pale green on both sides. *Rubus Caesius*, L.

β. Prickles usually recurved, shoots not glaucous, leaflets dark green above and pale or white beneath, sometimes glandular. *Rubus fruticosus*, L.

(*b*) Pinnate leaves with at least 5 leaflets.

(*i*) Leaves exstipulate.

α. Leaves hard and very dark polished, evergreen. Leaflets spinose-toothed. Small bush. *Berberis Aquifolium*, Ph.

β. Leaves neither hard and polished nor evergreen; leaflets not spinescent-toothed. Large trees, with stout shoots and broad leaf-scars.

* Leaflets 5-13, oblong-lanceolate, entire or sinuate, fragrant. Twigs smooth, pith chambered. *Juglans regia*, L.

* * Leaflets 15-25 ovate-lanceolate, glandular-serrate at base, not scented, shoots pubescent, pith continuous. *Ailanthus glandulosa*, Desf.

(*ii*) Leaves stipulate

α. Stipules usually as lateral spines, buds buried in base of petiole, leaflets entire. *Robinia pseudacacia*, L.

β. Stipules not spinose and buds not buried, leaflets serrate or bi-serrate.

* * * *

(2) Leaves palmate, digitately 5-foliolate with tendrils opposed to some of them. *Ampelopsis hederacea*, Mœnch.

II. Leaves simple.—

A. Leaves opposite or rarely in whorls of 3-4.

(1) Leaves stipulate.

(*a*) Leaves 3-5 lobed, broad ovate-rhomboid with sessile glands on the top of the petiole and linear fringe-like stipules below. *Viburnum Opulus*, L.

(*b*) Leaves not lobed, ovate or lanceolate; petioles eglandular, stipules very minute or half-ovate, caducous or obsolete.

* * * *

(2) Leaves exstipulate.

(*a*) Leaves lobed, palmatifid and with palmate venation. Petioles long.

(*i*) Leaves large, 10-20 cm. or more in diameter.

α. Lobes more or less ovate, sinus between any two narrow and acute, coarsely and irregularly cut into blunt teeth or lobules apex bluntly acuminate, sap watery. *Acer pseudoplatanus*, L.

β. Lobes angular, apex and teeth drawn out into long acuminate points, sinus wide and hardly acute. Latex white. *Acer platanoides*, L.

(*ii*) Leaves small 6-12 cm. in diameter. Latex white. *Acer campestre*, L.

(*b*) Leaves not lobed.

(*i*) Leaf-margin serrate or dentate.

α. Leaves lanceolate, polished, evergreen coriaceous. *Aucuba japonica*, Thunb.

β. Leaves ovate or elliptic, not polished or evergreen nor coriaceous.

* Leaves and shoots greyish mealy with stellate hairs, margins dentate serrate, venation pinnate with numerous forked secondaries. *Viburnum Lantana*, L.

* * Leaves glabrous or nearly so, matt green, finely serrate. Venation pinnate with few arched secondaries. *Rhamnus catharticus*, L.

* * *

B. Leaves alternate:—

(1) Leaves lobed.

(*a*) Lobing and venation pinnate.

* * *

(*b*) Lobing and venation palmate.

(*i*) Leaves exstipulate.

α. Leaves dark green, shining, coriaceous and evergreen. Shoots climbing by adventitious roots. *Hedera Helix*, L.

β. Leaves not dark, shining, coriaceous or evergreen, shoots not climbing.

* Pulvinus armed with single or triple spines. Leaves 3-6 cm. in diameter. *Ribes grossularia*, L.

** Shoots and pulvini devoid of spines. Leaves 6-12 cm. broad.

† Leaves strongly aromatic when bruised, owing to yellow glandular hairs beneath. *Ribes nigrum*, L.

†† Leaves devoid of glands and strong odour. *Ribes rubrum* L.

* * *

(2) Leaves not lobed

(*a*) Leaves serrate, dentate or crenate

(*i*) Leaves stipulate

α. Leaves distichous on long lateral shoots

* Leaves more or less lanceolate.

† Leaves coriaceous, polished above, evergreen, glandular serrate, venation pinnate, reticulate and looped, obscure

§ Shoots and petioles green, leaves oblanceolate, secondaries slightly prominent beneath with circular gland at the base beneath on each side of the mid-rib. *Prunus Laurocerasus*, L.

§§ Shoots and petioles reddish to purple, leaves ovate lanceolate, venation less prominent, no glands. *Prunus Lusitanica*, L.

* * *

APPENDIX II.

List of Species arranged according to susceptibility to Frost-Damage.

Class I.—Frost-hardy.

1. Phoenix acaulis.
2. „ sylvestris.
3. Zizyphus Jujuba.
4. Acacia Catechu.
5. „ leucophloea.
6. Gardenia turgida.
7. Limonia acidissima.
8. Carissa spinarum.
9. Acacia pennata.
10. „ caesia.
11. Salix tetrasperma.
12. Dendrocalamus strictus.
13. Ægle Marmelos.
14. Stereospermum suaveolens.

Class II.—Less hardy.

15. Ougeinia dalbergioides.
16. Elaeodendron glaucum.
17. Eugenia operculata.
18. Grewia vestita.
19. Shorea robusta.
20. Mallotus philippinensis.
21. Woodfordia floribunda.
22. Ficus glomerata.
23. Terminalia Arjuna.
24. „ tomentosa.
25. „ Chebula.
26. Mangifera indica.
27. Butea frondosa.

Class III.—Frost-tender.

28. Lagerstroemia parviflora.
29. Anogeissus latifolia.
30. Ficus bengalensis.
31. Holarrhena antidysenterica.
32. Tectona grandis.
33. Terminalia belerica.
34. Miliusa velutina.
35. Schrebera swietenioides.
36. Diospyros tomentosa.
37. Bauhinia racemosa.
38. Phyllanthus Emblica.
39. Buchanania latifolia.
40. Flacourtia Ramontchi.
41. Zizyphus Oenoplia.
42. „ xylopyra.
43. Odina Wodier.
44. Dalbergia paniculata.
45. Helicteres Isora.
46. Millettia auriculata.
47. Ehretia laevis.

APPENDIX III.

New Indian Species since publication of Brandis' *Indian Trees* (1906).

Acer Osmastoni *Gamble.* (Kew Bull., 1908, p. 446) Darjeeling.
Adenosacme chasalioides, *Craib.* (Kew Bull., 1911, p. 190) Burma.
Albizzia Lathamii, *Hole.* (Ind. For. Rec. IV. 4, p. 153) Madras.
Allophylus subfalcatus, *Radlk.* (Rec. Bot. Survey Ind., III, p. 342) Assam and Bengal.
Antidesma Collettii, *Craib.* (Kew Bull., 1911, p. 461) Burma.
Aristolochia punjabensis, *Lace.* (Kew Bull., 1911, p. 273) Punjab.
A. Hookeriana, *Craib.* (Kew Bull., 1911, p. 450) Burma.
Arundinaria Maling, *Gamble.* (Kew Bull., 1912, p. 139) Sikkim.
Beaumontia brevituba, *MacGregor and Smith.* (Rec. Bot. Sur. Ind., IV, p. 278) Burma.
Beilschmiedia Robertsoni, *Gamble.* (Kew Bull., 1912, p. 200) Burma.
Berberis Parkeriana, *C. K. Schn.* (Fedde Rep. Sp. Nov. 1912) Punjab.
Boschia Mansoni, *Gamble.* (Kew Bull., 1908, p. 445) Burma.
Butea pellita, *Hook f.* (Kew Bull., 1908, p. 386) Kumaon, Naini Tal.
Calamus Delessertianus, *Becc.* (Ann. Calc. XI, p. 276) S. India.
C. Hookerianus, *Becc.* (Do. p. 226) Coromandel.
C. Khasianus, *Becc.* (Do. p. 431) Assam.
C. Kingianus, *Becc.* (Do. p. 197) Assam.
C. leucotes, *Becc.* (Do. p. 309) Burma.
C. Metzianus, *Schlecht.* (Do. p. 221) Kanara.
C. nambariensis, *Becc.* (Do. p. 433) Assam.
C. polydesmus, *Becc.* (Do. p. 430) Burma.
Cedrela Kingii, *C. Dc.* (Rec. Bot. Sur. Ind., III., p. 371) Sikkim.
C. longifolia, *Wall.* (Do. p. 375) Kumaon.
C. Mannii, *C. Dc.* (Do. p. 374) Assam.
Cereus pterogonus, *Lemaire.* (Rec. Bot. Sur. Ind., IV., p. 294) Bengal, Burma.
Clematis zemuensis, *W. W. Smith.* (Do. p. 166) Sikkim
Cornus controversa, *Hemsl.* (Kew Bull., 1909, p. 331) Sikkim, Assam.
C. Stracheyi, *Hemsl.* (Do. p. 333) Kumaon.
Craibiodendron shanicum, *W. W. Smith.* (Rec. Bot. Sur. Ind. IV, p. 277) Burma.

Cynometra Bourdilloni, *Gamble.* (Kew Bull., 1908, p. 446) Travancore.

Dalbergia Lacei, *Prain.* (Kew Bull., 1907, p. 58) Burma.

D. maymyensis, *Craib.* (Kew Bull., 1912, p. 390) Burma.

Decaschistia rufa, *Craib.* (Kew Bull., 1912, p. 35) Madras.

Dillenia Kerrii, *Craib.* (Kew Bull., 1911, p. 8) Burma.

Dioscorea Daunaea, *Prain and Burkill.* (Journ. As. Soc. Beng., 1908, p. 450) Burma.

D. Listeri, *Prain and Burkill.* (Journ. As. Soc. Beng., 1908, p. 452) Assam.

D. melanophyma, *Prain and Burkill.* (Journ. As. Soc. Beng., 1908, p. 453) N. W. Himalayas.

D. Wattii, *Prain and Burkill.* (Journ. As. Soc. Beng., 1908, p 457) Assam, Bengal.

Elæocarpus Robertsoni, *Gamble.* (Kew Bull., 1912, p. 199) Burma.

Euonymus scandens, *R. Graham.* (Kew Bull., 1908, p. 33) Nepal.

Euphorbia Lacei, *Craib.* (Kew Bull., 1911, p. 456) Burma.

Garuga Gamblei, *King.* (Rec. Bot. Sur. Ind., IV, p. 262) Sikkim.

Grewia Lacei, *Drummond and Craib* (Kew Bull., 1911, p. 21) Burma.

Gymnema Griffithii, *Craib.* (Kew Bull., 1911, p. 416) Burma.

G. Lacei, *Craib.* (Kew Bull., 1911, p. 191) Burma.

Hedera himalaica, *Tobler.* (Die Gattung Hedera, 1912) Himalayas.

Hedyotis sisaparensis, *Gage.* (Journ. As. Soc. Beng., 1905, p. 244) Madras.

Hibiscus Watsoni, *W. W. Smith.* (Kew Bull., 1912, p. 198) Burma.

Illigera trifoliata, *Dunn.* (Journ. Linn. Soc. 38, p. 294) Assam, Burma.

Indigofera Lacei, *Craib.* (Kew Bull., 1910, p. 382) Burma

Irvingia Oliveri, *Pierre.* (Rec. Bot. Sur. Ind., IV, p. 276) Burma.

Lagerstroemia Collettii, *Craib.* (Kew Bull., 1911, p. 53) Burma.

Lepisanthes assamica, *Radlk.* (Rec. Bot. Sur. Ind., III, p. 343) Assam.

L. basicardia, *Radlk.* (Do. p. 345) Burma.

L. granulata, *Radlk.* (Do. p. 344) Burma.

L. Listeri, *King.* (Do. p. 344) Assam.

Lespedeza sessilifolia, *Gamble.* (Kew Bull., 1912, p. 199) Burma.

Manglietia Hookeri, *Cubitt and Smith.* (Rec. Bot. Sur. Ind., IV, p. 273) Burma.

Melodorum minuticalyx, *McGregor and Smith.* (Rec. Bot. Sur. Ind., IV, p. 274) Burma.

60. Millettia Cubitti, *Dunn.* (Journ. Linn. Soc., XLI, p. 188) Burma
M. eriocalyx, *Dunn.* (Do. p. 150) Burma.
M. Griffithii, *Dunn.* (Do. p. 146) Burma.
M. podocarpa, *Dunn.* (Do. p. 166) Burma.
M. Prainii, *Dunn.* (Do. p. 174) Sikkim.
65. M. trifoliata, *Dunn.* (Do. p. 165) Burma.

Mussaenda Treutleri, *Stapf.* (Bot. Mag. V. t. 8254) Sikkim, Assam.

Myxopyrum serratulum, *A. W. Hill.* (Kew Bull., 1910, p. 41) Travancore, S. India.

Nyctocalos shanica, *McGregor and Smith.* (Rec. Bot. Sur. Ind., IV., p. 280) Burma.

Opuntia cochinelifera, *Mill.* (Rec. Bot. Sur. Ind., IV, p. 292) India and Burma.

70. O. elatior, *Mill.* (Rec. Bot. Sur. Ind., IV, p. 293) throughout India.
O. monacantha, *Haw.* (Do. p. 292) India and Burma.
O. nigricans, *Haw.* (Do. p. 293) Bengal.

Oritrephes septentrionalis, *W. W. Smith.* (Journ. As. Soc. Beng., 1911, p. 69) Burma.

Osbeckia Hildebrandii, *Stapf.* (Kew Bull., 1911, p. 269) Burma.

75. O. racemosa, *Craib.* (Kew Bull., 1911, p. 51) Burma.

Oxytenanthera Lacei, *Gamble.* (Kew Bull, 1910, p. 385) } Burma.
Do. 1911, p. 192) }

Paradombeya multiflora, *Gamble.* (Kew Bull., 1912, p. 198) Burma.

Paranephelium hystrix, *W. W. Smith.* (Rec. Bot. Sur., IV, p. 275) Burma.

Pentapterygium sikkimense, *W. W. Smith.* (Do. p. 268) Sikkim.

80. Piper longicaule, *C. Dc.* (Rec. Bot. Sur. Ind., IV, p. 11) Madras.

Pittosporopsis Kerrii, *Craib.* (Kew Bull., 1911, p. 28) Burma.

Pogostemon hispidus, *Prain.* (Kew Bull., 1908, p. 254) Assam, Burma.

Prunus macrophyllus, *Sieb and Zucc.* (Rec. Bot. Sur. Ind., IV, p. 276) Burma.

Pueraria alopecuroides, *Craib.* (Kew Bull., 1910, p. 276) Burma.

85. Sambucus Wightiana, *Wall.* (Kew Bull., 1909, p. 192) Punjab.

Stereospermum grandiflorum, *Cubitt and Smith.* (Rec. Bot. Sur. Ind., IV, p. 280) Burma.

Strobilanthes Meeboldii, *Craib.* (Kew Bull., 1910, p. 278) Bombay, Mysore.

Styrax Lacei, *W. W. Smith.* (Kew Bull., 1911, p. 344) Burma.

Terminalia tripteroides, *Craib.* (Kew Bull., 1912, p. 152) Burma.

90. Uraria Lacei, *Craib.* (Kew Bull., 1910, p. 276) Burma, Assam.

Vernonia comorinensis, *W. W. Smith.* (Rec. Bot. Sur. Ind., IV, p. 283) Madras.

V. Dalzelliana, *Drummond and Hutchinson.* (Kew Bull., 1909, p. 261) Bombay.

Wormia Mansoni, *Gage.* (Journ. As. Soc., Beng., 1906, p. 73) Burma.

Wrightia sikkimensis, *Gamble* (Kew Bull., 1908, p. 447) Bengal.

95. Xerospermum intermedium, *Radlk.* (Rec. Sur. Ind., III, 349) Burma.

Xylia Kerrii, *Craib and Hutchinson.* (Kew Bull., 1909, p. 357) Burma.

APPENDIX IV.

Scope and Function of a Descriptive List and Flora respectively.

Flora.	Descriptive List.
1. Primary object is to serve as a Book of Reference for Forest Officers.	1. Primary object is to facilitate identification of all important species by those who have no special knowledge of botany and so far as possible at different seasons of the year.
2. Size of the Book is a minor consideration as it is not especially intended for use in the field.	2. The Book must be sufficiently small to serve as a convenient pocket-companion for use in the field, say $6\frac{1}{4}'' \times 4\frac{1}{2}''$.
3. Owing to the detailed nature of the Book, extensive knowledge, a long period of time and considerable expenditure are necessary for its production.	3. The Book is a relatively small publication which can be quickly, easily and cheaply produced.
4. It is advisable to reduce overlap and duplication of work so far as possible.	4. Duplication of work and overlap are considerations of minor importance.
5. It is advisable to deal with a large area and a considerable number of species. As a general rule it will probably be advisable not to deal with an area of less than that of a single Province.	5. It is advisable to deal with a small area and relatively few species. As a general rule it will probably be advisable not to deal with an area larger than that of a single Circle and in some cases the area should be smaller still.
6. Simple keys will as a rule be impossible and all that can be done will probably consist in giving a brief synopsis of the botanical characters of the families and then a single botanical key under each family to the genus and again under each genus to the species, similar to those given in Brandis' *Flora of N. W. and Central India.*	6. At least two simple keys leading to the species and based on characters which can be recognised in the forest with not more than the aid of a pocket-lens are absolutely essential. Detailed botanical descriptions of Orders, Families, Genera and Species are not required.

7. Probable advisable to limit the vernacular names to a selection of those most widely used.
8. Should be illustrated.
9. Should not be undertaken until the material collected for it is considered to be sufficiently complete to obviate the necessity for an early revision.

7. All reliable vernacular names current in every Division must be included.
8. Illustrations not required.
9. Must be published quickly to supply the urgent need of a publication calculated to facilitate wide-spread identification work.
10. The preparation of these books will necessitate the careful study of the vegetation over small areas and will thus aid the collection of the information which is essential for the preparation of the Floras.
11. The preparation of these Books and of periodic *addenda-corrigenda* to them, will indicate the areas which have been sufficiently studied to justify the preparation of Floras and will also indicate the areas which should be dealt with in the Floras in order to avoid undue overlap and duplication of work.
12. The preparation of these books will train and bring forward those men who in the future should be entrusted with the preparation of the Floras.

APPENDIX V.*

Summary of Information which it is proposed to include in the Descriptive Lists.

I. **Introduction.**

II. **Keys to the Species** based on the following 4 classes of characters and not requiring more than a pocket-lens for their recognition :

(*a*) Habit, Dimensions, Bark, Blaze, Twigs, Juice, Buds, and Periodicity.

(*b*) Leaves.

(*c*) Flower and Inflorescence.

(*d*) Fruit and Seed.

III. **A short account of each species** arranged in order under the correct Families and Genera of which the following is given as a sample :

---

* The schedule which accompanies this Appendix may be found useful for collecting from local forest officers the information required for the Descriptive Lists. The schedules could be conveniently printed in books, each of 50 or 100 forms, and space would be economised by using abbreviations, so far as possible, when making the entries, thus T. for tree, S. for shrub and so on. The duplicate could be torn off and sent with the specimen, while the counterfoil would remain on record in the book.

[NOTE.—The collector's name with date and locality of collection were not included in the schedule originally prepared for the Board of Forestry, as it was thought that this information would in any case be entered in the ordinary numbered collectors' tickets attached to the specimens and that its inclusion in the schedule would unnecessarily increase the length of the latter. On further consideration, however, I think it is advisable to include these details and this has accordingly been done in the schedule given below by slightly altering the heading of the form and without increasing the size of the latter. Collectors should in any case be required to tie on to the specimens themselves small tickets bearing the number of the specimen which will correspond to the number entered in the schedule. The present schedule has been prepared in what is believed to be a compact and handy form (ordinary foolscap size) but the precise size and shape is a point of minor importance and local officers will no doubt adopt that which appears most convenient to them. Thus Mr. C. E. Muriel, Conservator of Forests, Bengal, who originally suggested the preparation of these schedules, has recently informed me that he proposes to keep the schedules in loose sheets and not to have them perforated, to place one sheet with the specimen to which it relates and to have duplicate copies made on separate sheets with zanetic carbon paper. In this way far more space is available for the entries.—R. S. H.]

TECTONA GRANDIS, *Linn.* (The Teak tree). * Br. 505 : * G. 526.

Vern. *Sagon* (general) *H*.*; *teka* (Man* : *Gondi*); *sipna* (Mel.*).

Deciduous tree, locally * $\frac{60}{6}$, bark peeling in long thin flakes, twigs quadrangular. *L.* simple, opp., length often exceeding 12 *in.*, stellate tomentose below. *Fls.* small white in large panicles. *Fr.* hard, 4-celled, enclosed in spongy pericarp and surrounded by inflated bladdery calyx.

Fls. *July.–Aug.*; fr. *Nov-Jan.*; leaves fall *Nov.-Feb.*; leaves renewed *May-July.*

In deciduous forest in all Divisions up to 2,000 *ft.*, occasionally gregarious on alluvial flats and rocky ground.

Most valuable local timber. Wood yields an aromatic oil used medicinally, as a substitute for linseed oil and as a varnish. Leaves contain a red dye and are used as plates, umbrellas, for packing and thatching. Flowers and young fruit said to be diuretic.

IV. **Key to principal woods**

V. **Sylvicultural and Oecological Lists** of chief Species arranged according to their relative capacity to :—

(*a*) endure shade, (*b*) resist frost,

(*c*) coppice strongly, (*d*) reproduce vigorously by root-suckers,

(*e*) thrive in very dry habitats, (*f*) thrive on water-logged soil,

(*g*) thrive on land-slips and shifting sands,

(*h*) grow rapidly during youth,

(*i*) resist fire-damage,

(*j*) resist damage by grazing.

VI. **Glossary**

VII. **Indexes** to Vernacular and Scientific Names.

VIII. **Distribution--Maps.**

---

* Br. = Brandis' *Indian Trees*, G. = Gamble's *Manual of Indian Timbers*, *H.* = Hindi, Man. = Mandla Division, Mel = Melghat Division.

$\frac{60}{6}$ = attaining a height of 60 ft. and girth of 6 ft. All such abbreviations would naturally be explained in the Introduction.

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Note on Turpentines of *Pinus Khasya*, *P. Merkusii* and *P. excelsa*

BY

PURAN SINGH, F.C.S.,

Chemical Adviser to the Forest Research Institute, Dehra Dun.

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INTRODUCTION.

At the meeting of the Board of Forestry, held in April 1910, it was decided to examine the resins of the principal conifers of India with reference to the production of oil of Turpentine. Of the principal Indian conifers *Abies Pindrow*, *Picea Morinda*, and *Pinus Gerardiana* occur generally in localities so remote as to preclude the possibility of their being profitably worked for turpentine. *Cedrus Deodara* is far too valuable on account of its timber to permit of its being tapped, but the question of extracting the so-called Deodar oil from the stumps left in the forests will no doubt be studied separately at the Forest Research Institute. This peculiar oil has some reputation as a medicinal agent in the Indian systems of medicine, and is likely to prove different from the ordinary oil of turpentine. The turpentine from *Pinus longifolia* has been dealt with in Indian Forest Records, Vol. IV, Part I, while specimens of oil obtained from the resins of *Pinus Khasya* and *Pinus Merkusii* from Burma were examined in 1896 by Professor H. E. Armstrong, F.R.S., whose report is quoted below.

The only species remaining for consideration was therefore *Pinus excelsa*, which occurs fairly extensively, and the tapping of which has, it is stated, already been taken up to some extent in the Punjab. The resin from this tree has now been examined, and together with it the resins from *Pinus Khasya* growing in Burma and Assam, respectively. The latter were included in the investigation with the object of determining their percentage composition and usual constants, but it was

incidentally found that there was a remarkable difference in quality between the oils of Burma and Assam origin. It was, therefore, considered worth while to examine the Assam oil and to get it valued at the Imperial Institute, London. Professor Dunstan's interesting report will be found on page 6.

The resin of *Pinus Merkusii* of Burma has not been dealt with, as the oil obtained from it has already been proved by Professor Armstrong to be similar to that from *Pinus Khasya*.

Area under *Pinus Khasya* and *Pinus Merkusii* and yield.

No definite data are available as to the areas covered by these two species in Assam and Burma. In the Handbook of Commercial Products, No. 7 of the Imperial Institute Series, published in 1893, the available area under *Pinus Khasya* in Assam is stated to be 33 square miles, and that under *Pinus Merkusii* in the Thaungyin valley of the Tenasserim Circle in Burma 50 square miles. This estimate may be correct for Assam, but the figures given for Burma are incomplete. The Chief Conservator of Forests, Burma, in reply to a query by the writer, wrote that there seems to be an inconsiderable pine area in the Northern Circle, the Myitkyina, Lower Chindwin, Myittha, and Upper Chindwin Divisions, all taken together, being estimated to contain not more than 6 square miles. The Superintendent of the Chin Hills was unable to give any estimate at all. In the Tenasserim Circle *Pinus Khasya*, sometimes pure and at other times mixed with oaks, chestnuts, and other trees, is found over an area estimated at about 50 square miles, on most of the ridges over 2,500 feet elevation round Lomati in the Papun Township. The latest estimate for the Thaungyin Division of the same Circle is, however, only 29 square miles.

The Conservator of Forests, Southern Circle, reports the existence of very large forests of pine in the Maing Lon State to the south of Mogôk, but says there is no information available as to their extent or the number of trees. He also states that there are about 75 square miles of pine forest in the Northern Shan States of Mongtung. In the Yaw Division pine is said to exist in the Pakôkku Hill Tracts and Chin Hills at an elevation of from 4,000 to 8,000 feet, but the area is not known. The Conservator thinks that a careful examination of the forests would have to be made to obtain any reliable information, and that such examination would take at least two months. The most complete information comes from Mr. Watson, Deputy Conservator of Forests in the Southern States. Mr. Watson estimates the total area under

pine in his Division to be 3,000 square miles, of which he considers about 1,400 square miles might be worked under the present conditions of transport. The Conservator, remarking on Mr. Watson's letter, says that, reckoning that only trees of 4 feet and over in girth are fit to tap, Mr. Watson's small sample plot (which, however, can hardly be considered as an average plot for so large an area,) indicates an available stock of 17,280 trees per square mile or a total on 1,400 square miles of over twelve million trees, even if an allowance of 50 per cent. be made for depreciation by *taungya* cutting. The Conservator thinks, however, that the information given requires confirmation and ought to be supplemented later on by more exact observations. In this connection the following extract from Mr. Watson's letter to the Conservator is of interest :—

"I would roughly estimate the areas under pine in this Division as follows :—

	sq. miles.	
1. Myelat States	300	*Pinus Khasya.*
2. Lawksawk State	300	
3. Loilong and Mongpai State	300	
4. Mongpawn and Laihka	150	
5. Mong Kung State	300	
6. Hsatung State	50	*Pinus Merkusii.*
7. Mongnai State	100	Both species: probably 70% *P. Merkusii* and 30% *P. Khasya.*
8. Mawkmai State	100	
9. Mongpan State	600	
10. Kengtung (Mongpu and Monghsat)	800	
Total	3,000	

"Under existing conditions of communications and transport the last four States need hardly be considered.

"A sample area of two acres counted at Kalaw gave the following results :—

	Below 3′	3′ to 4′	4′ to 5′	5′ and over.	
Pine	17	41	43	11	*Pinus Khasya* only.
Other species	21	7	2	9	

"This works out at 30,400 pine over 3 feet in girth per square mile. I should say, however, that the pine forests in the first 6 areas noted

above are 50 per cent. depreciated through *taungya* cutting and wasteful use; so I would not estimate the stock of trees over 3 feet girth at more than half this figure per square mile."

Professor Armstrong's report on oil of *Pinus Khasya* and *Pinus Merkusii* from Burma.

Professor H. E. Armstrong, F. R. S., was the first to examine specimens of these two oils distilled from resins obtained from Burma. He wrote a short report* on them in April 1896, which may well be quoted here :—

"The crude turpentine from *Pinus Khasya* was a grey, thick, pasty mass, containing a quantity of small pieces of wood. That from *Pinus Merkusii* was more fluid, and cleaner in appearance.

"By distilling with steam I separated about 13 per cent. of its weight of oil from the *Pinus Khasya* turpentine and nearly 19 per cent. from the *Pinus Merkusii* turpentine. On a previous occasion I obtained 17 per cent. of oil from a sample of the first-named turpentine. I imagine that the present supply of turpentine was collected under less favourable conditions and that some oil was lost by evaporation in the case of the sample now under examination."

"The original turpentine and the distilled oil in each case have a very slight but agreeable odour, which is even less pronounced than that of French turpentine, and distinctly characteristic, although indescribable. The two oils are very similar in this respect.

"I am satisfied that the oil from *Pinus Khasya* is identical with that which I received from the Colonial and Indian Exhibition and examined several years ago.

"The oil from *Pinus Merkusii* is very similar to that from *Pinus Khasya*."

"Like French oil of turpentine, both these oils distil within a very narrow range of temperature, near to 155°C., but the oil from *Pinus Khasya* appears to contain a somewhat larger proportion of a constituent of higher boiling point.

"The two oils are very nearly alike in relative density at 20° C., that of *Pinus Khasya* being ·8627 and that of *P. Merkusii* ·8610. They both turn the ray of polarised light to the right, the so-called specific rotatory power being + 36° 28′ for *Pinus Khasya* and + 31° 45′ for *Pinus Merkusii*. The rotatory power of French turpentine is practically always about—36°. The *Pinus Khasya* oil now examined agrees in this respect with that I previously obtained from British Burma.

* Imp. Inst. Tech. Rep. 1903, pp. 167-169.

"Practically, French oil of turpentine and that from *Pinus Khasya* exactly correspond in properties. The difference between the oils from the two Burmese turpentines is of such a kind as to be of no practical consequence—they are essentially similar, and the slight difference is due to the presence, in one or the other, of some substance besides the chief constituent. . . . . .

"Meanwhile, I may say that both oils are of the highest quality, and that I believe they would serve every purpose for which oil of turpentine (French or American) is used. They even compare favourably with the French oil, which is of the highest quality in the market."

Examination at Dehra Dun of resin of *Pinus Khasya* from the Shan States.

The resin of *Pinus Khasya*, a pound of which was received from the Southern Shan States, was re-examined in 1911 in the laboratory of the Forest Research Institute. It yielded 17·8 per cent. of oil and 74·5 per cent. of rosin, ·75 per cent. of insolubles, and 6·95 per cent. of moisture (by difference). The crude resin gave the following constants :—

Saponification number (determined hot after one hour)	136·72
Acid number	120·15
Ester number	16·57
Iodine number (Hubl. 18 hours)	234·54

The oil distilled from this resin had a specific gravity of 0·8559 at 29°C. On fractional distillation in an ordinary distillation flask it gave the following fractions :—

150°–155°C.	76%
155°–160°C.	20%
Residue and loss	4%

Its iodine value, when quite fresh, was 306·3, but rose to 406·6 after six months. The (α) D, or the specific rotatory power, of the oil, as determined at Dehra Dun, was $+34°8'$ after one year. The fractions and other constants agreed well with those determined by Professor Armstrong, the heavier portion of the oil referred to in his report also passing below 160°C. In short, the results confirm Professor Armstrong's report that the Burma turpentine oil from *Pinus Khasya* is equal in quality to high grade French and American oils.

The rosin of *Pinus Khasya* from Burma.

The rosin from this species, as obtained in the laboratory, gave the following constants, from which it is clear that it is of the standard quality :—

Sp. gr. at 29°C.	1·0648
Saponification number (determined hot after one hour)	173·93
Acid number	159·76
Ester number	14·17
Iodine number (Hubl. 18 rs.)	196·82

Examination at Dehra Dun of oil of *Pinus Khasya* from Assam.

The writer obtained 80 lbs. of crude turpentine of *Pinus Khasya* from Assam to determine its percentage composition and usual constants, as well as to prepare a sample of *Khasya* oil.

It was incidentally found that the oil obtained did not give the same fractions as the oil obtained from the Burma resin. It had a specific gravity of ·8733 at 15°C. and an optical rotation of −2° in 100mm. tube. Its iodine value was 420·7.

The fractions were—

150°−155°C.	3·5%
155°−160°C.	67·0%
160°—165° C.	24·0%
Residue and loss	5·5%

The oil is thus somewhat inferior in quality to the Burma oil, as it contains a greater proportion of high boiling terpenes. The species being the same this difference is remarkable and seems to be due to the difference in the climatic conditions of the two provinces. As already stated the Assam oil was valued in London, but no such valuation was considered necessary in the case of the Burma oil, since tests of the latter made in the Laboratory of the Forest Research Institute gave results similar to those obtained by Professor Armstrong.

Professor Dunstan's report on the oil of *Pinus Khasya* from Assam.

Professor Dunstan reports on the Assam oil as follows :—

"This was a pale yellow oil with an odour resembling that of the best grades of American turpentine but rather sweeter.

"It had the following constants :—

Specific gravity at 15° C./15° C.	0·870
Optical rotation in 100 mm. tube	−4°50′
Specific rotatory power (a) D =	−5°30′

"The oil was fractionally distilled with the following results :—

Fraction boiling at	Per cent. of oil distilled.	Specific gravity at 15° C/15°C.	Optical rotation in 100 mm. tube.
About 162° to 163° C.	25	0·869	−1°50′
163° to 165° C.	57	0·870	−4°40′
165° to 169° C.	11	0·871	−10°40′
Residue and loss	7	0·895	−7°30′

"These results show that the sample is a moderately good turpentine oil, boiling within a fairly narrow range of temperature. The optical rotations indicate, however, that it is a mixture of terpenes, and it does not meet the requirements laid down for the best American turpentine oil, *viz.*, that not less than 70 per cent. of the oil by volume should distil between 155° and 160° C. Apart from its colour, however, it is quite equal to the lower grades of American oil, in which it is required that at least 60 per cent. should distil below 170°.

"The yellow tint of this oil could be easily removed by re-distillation.

"In connection with this sample it may be pointed out that a specimen of turpentine oil stated to be derived from *Pinus Khasya*, which was forwarded to the Imperial Institute from Burma and examined in 1896, is described in the Imperial Institute 'Technical Reports and Scientific Papers,' page 168. The optical rotation of this earlier sample differed very considerably from that observed in the present instance, its specific rotatory power being + 36°28′."

The pale colour of the oil noticed by Professor Dunstan is due to storage, an interval of about 4 months having elapsed between the preparation and the examination of the oil. When fresh it was quite colourless. In this connection it may be stated that storage causes a similar change of colour in the case of the American oil also. But the oil of *Pinus Khasya* seems to undergo a somewhat abnormal oxidation, a specimen with a specific gravity of ·8559 giving a specific gravity of ·914 after one year. Hence it is recommended that, if it has been stored for a long time, *Khasya* oil should be refined before it is placed on the market. Re-distillation, as suggested by Professor Dunstan, is of course the best method of refinement, since thereby are removed not only the colour but other resinous impurities which are mechanically distilled over along with the oil and which hasten the process of discolouration.*

The oil of *Pinus Khasya* from Assam differs from that of the Burma pines in its optical rotation and in its somewhat larger proportion of

* The writer recently suggested placing a catch-still between the main still and the condenser in order to arrest the resinous impurities during the process of distillation. By the adoption of this idea the oil distilled from the oleo-resin of *Pinus excelsa* was colourless even after 10 months' storage. It appears that in the laboratory the catch-still refines the oil almost to the same extent as, and therefore obviates the necessity for, re-distillation, provided a temperature of from 95°—98°C. is maintained (98° being the temperature of distillation of the mixed vapours of turpentine and water), though whether this will prove to be the case on a large scale has yet to be determined.

heavy terpenes. It is due to the latter difference that it is classed with the second grade American turpentine oils. On the whole it occupies a position midway between the best American oil and the best oil of *Pinus longifolia*, which is the main source of the Indian oil of turpentine.

Area under *Pinus excelsa* in United Provinces and Punjab.

The following statement kindly compiled by Mr. R. S. Pearson, Forest Economist, gives roughly the area under *Pinus excelsa* in the United Provinces and the Punjab :—

Province.	Name of Forest or Division.	Area in acres.
United Provinces . .	1 Government forests in Jaunsar Bawar .	3,500
	2 Tehri-Garhwal leased forests . .	4,740
	Total .	8,250
Punjab	1 Hazara Forest Division . . .	13,000
	2 Tharoch State Forests, Simla Division .	1,700
	3 Jubal State Forests, Simla Division .	13,550
	4 Kangra Forest Division . . .	200
	5 Pangi leased forests, Chamba State .	6,000
	6 Bashahr Division	13,600
	7 Upper Ravi forests, Chamba Division .	8,250
	Total .	56,300
	GRAND TOTAL .	64,550, say 65,000 acres.

Examination of resin of *Pinus excelsa* at Dehra Dun.

The crude resin of *Pinus excelsa* received from the Divisional Forest Officer, Jaunsar, gave 18·82 per cent. of oil, 75·5 per cent. of rosin, 0·51 per cent. of insolubles and 5·17 per cent. of moisture (by difference). It had the following constants :—

Saponification number (determined hot after one hour) . .	144·7
Acid number	124·9
Ester number	19·8
Iodine number (Hubl. 18 hours)	142·1

The oil obtained from the resin had a specific gravity of 0·8583 at 20°C and was a colourless liquid, which, on fractional distillation, gave the following fractions :—

150-155°C.	90 per cent.
155-160°C.	7·5 ,,
Loss and residue	2·5 ,,

About 2 lbs. of this oil was sent to the Imperial Institute, London, for valuation. Professor Dunstan reports as follows on its quality :— Professor Dunstan's report on oil of *Pinus excelsa.*

"This oil was of pale yellow tint, and had an odour resembling that of the best American grades, but rather more pleasant. It furnished the following constants :—

Specific gravity at 15°C./15°C.	0·862
Optical rotation in 100 mm. tube	+36°40′
Specific rotatory power (α) D	+42°30′

"The oil was fractionally distilled with the following results :—

Fraction boiling at	Per cent. of oil distilled.	Optical rotation in 100 mm. tube.
157° to 158°C.	74	+37°10′
158° to 160°C.	16	+36°15′
160° to 170°C.	7	+34°10′
Residue and loss	3	...

"From these results it is clear that this sample of turpentine oil is of good quality ; 90 per cent. of the oil boils within the narrow range of 157° to 160° and consists mainly of dextropinene. The yellow tint could be easily removed by re-distillation before marketing and the oil would then be comparable with the best French and American turpentine oils.

* * * * * *

"The foregoing results show that the oil of *Pinus excelsa*, when re-distilled in order to remove the yellow colour,* is equal in quality to the best grades of French and American turpentine oil, and it is very probable that technical trials will show that the oil is equally suitable for industrial purposes.

* * * *

"In view of the good quality of the oil furnished by *Pinus excelsa* it seems desirable that the tapping of this species for turpentine should be encouraged, if the species is abundant in accessible areas and gives a good yield of oleo-resin."†

* See footnote, p. 7.

† The following is the concluding paragraph of Professor Dunstan's combined report on the oils of *Pinus Khasya* of Assam and *Pinus excelsa.*

"Samples of the re-distilled oils have been submitted to a firm of varnish-makers, and samples of the oils in their original condition to two firms of merchants. The reports obtained indicate that both these oils, if re-distilled before shipment in order to render them colourless, would be readily saleable in the United Kingdom. The merchants would not, however, express an opinion as to the exact commercial values of these oils without having an opportunity of seeing and testing bulk samples, and they suggested that for this purpose one ton of each kind of oil should be shipped to London for trial. They pointed out that this would also afford an opportunity of introducing these oils to manufacturing firms and of ascertaining their actual value for technical purposes.

The rosin from *Pinus excelsa*.

The rosin obtained from *Pinus excelsa* gave the following constants :—

Specific Gravity at 29°C.	106·4
Saponification number (determined hot after one hour)	173·9
Acid number	162·4
Ester number	11·5
Iodine number (Hubl. 18 hours)	105·1

Summary of Results.

The prospects of turpentine distillation in Burma.

From the preliminary estimates of the area of pine forest almost the only part of Burma likely to prove suitable for the establishment of turpentine distilleries is the Southern Shan States. It may therefore be suggested that, as the Burma pines yield a high quality of turpentine oil, a complete economic survey of the pine area in the Southern Shan States be undertaken as soon as possible. The distillation of turpentine oil cannot fail to be profitable if the conditions of transport are favourable, and these conditions, which will be vastly improved by the opening of the railway now under construction, should be studied in detail in order to form definite estimates of the cost of production.

The oil of *Pinus Khasya* from Assam.

The area under *Pinus Khasya* in Assam is quite negligible ; the cost of collection of the resin seems to be prohibitive ; and the oil is somewhat inferior in quality to that obtained from Burma. Assam turpentine seems therefore to offer few, if any, commercial possibilities.

The oil of *Pinus excelsa*.

As compared with *Pinus longifolia*, the forests of *Pinus excelsa* are limited in extent. But, as shown in this note, the oil obtained from the resin of *Pinus excelsa* is equal to the best grade American and French oils. It is therefore recommended that the tapping of this species should be extended, as far as possible, in order to produce better grades of turpentine oils in India. As remarked elsewhere * it seems improbable that *Pinus longifolia* oil alone will be able to replace some of the best grades of the American oil. It is necessary that the better qualities of oil from *Pinus Khasya*, *Pinus Merkusii*, and *Pinus excelsa* should also be brought in to meet the demand of the Indian market.

The rosins of *Pinus Khasya* and *Pinus excelsa*.

The rosins from the different species of pine, whether Indian, European, or American, do not differ much in quality. Their value depends on such physical properties as colour, texture, transparency, etc. In the case of *Pinus longifolia* resin distillation the necessity for employing high temperatures results in some discolouration of the rosin. But the turpentine of *Pinus Khasya* and *Pinus excelsa* can be driven off

* See Indian Forest Records, Volume IV, Part 1, page 71.

at considerably lower temperatures, so the resulting rosin should fetch a better price than that of *Pinus longifolia*. This view has, however, to be confirmed by experiments on a large scale, the results of laboratory tests being insufficient evidence.

Commercial valuation of the oils of *Pinus Khasya* and *excelsa*.

As remarked by Professor Dunstan, both these oils will be readily saleable in the United Kingdom. The English merchants consulted by Professor Dunstan would not, however, express an opinion as to the exact commercial values of these oils without having an opportunity of seeing and testing bulk samples for which purpose they require one ton of each oil to be shipped to London for trial. This trial is essential in order to get a definite idea of their commercial value in the United Kingdom. But the better grades of turpentine oil are so greatly in demand in this country that there seems to be no probability for a long time to come of exporting Indian turpentine oils to the United Kingdom. The railways being the chief consumers of turpentine in India, it will be better to have the bulk samples tested by them, but as the chemical examination shows them to be equal to high grade American turpentine oil, there should be no difficulty in selling these oils at very good prices in this country.

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